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JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF THE
AMERICAN DAIRY SCIENCE ASSOCIATION

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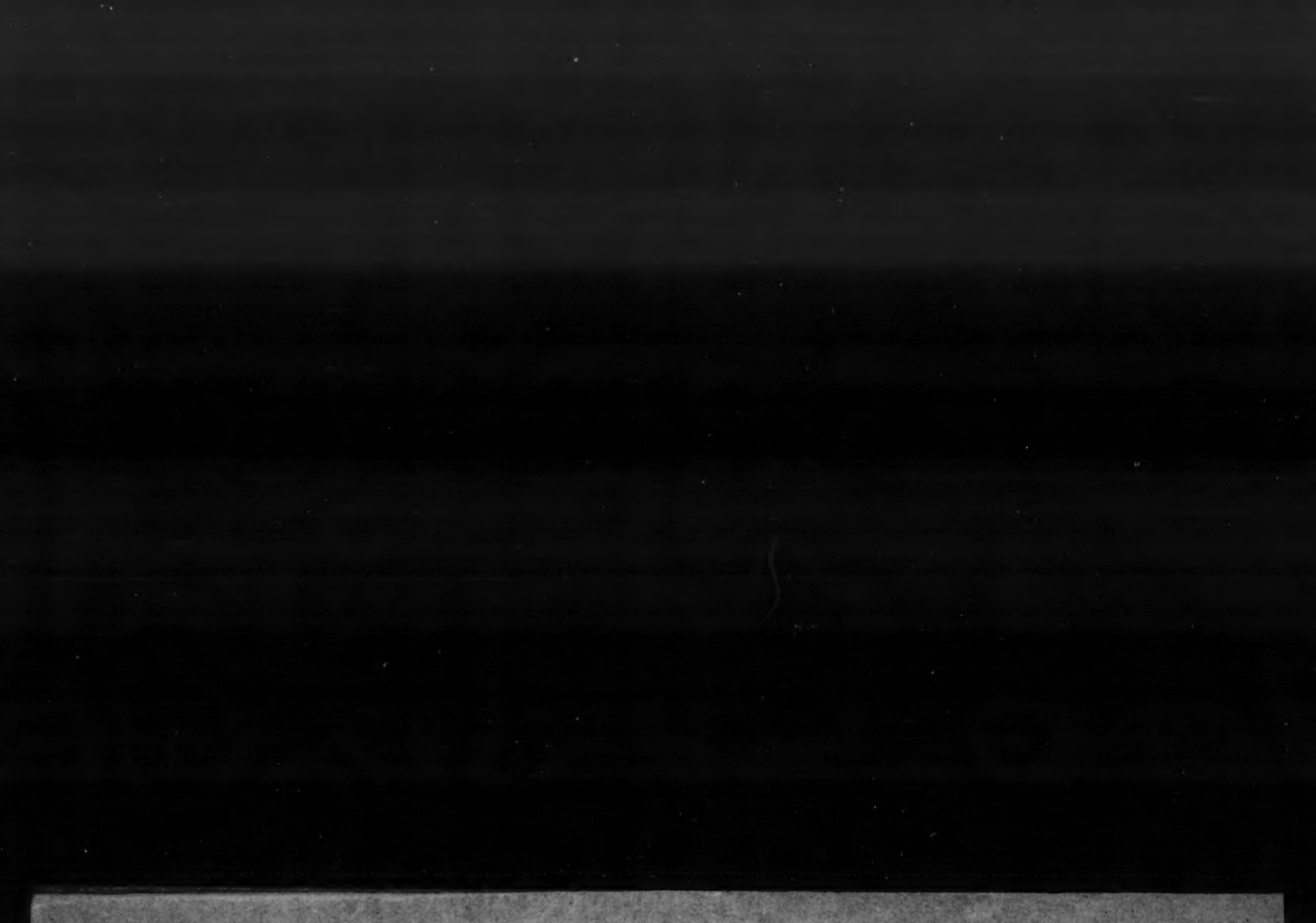

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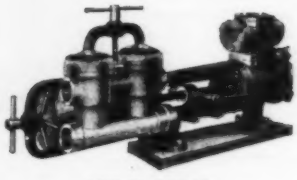

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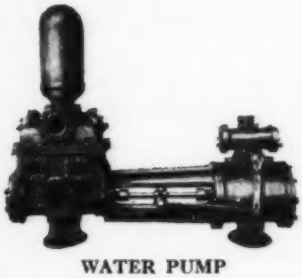

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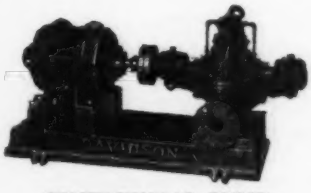

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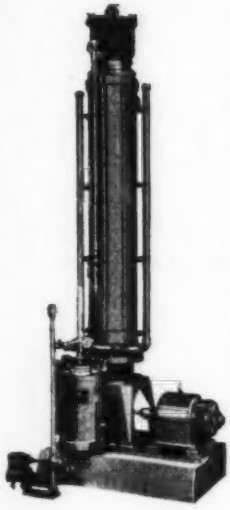

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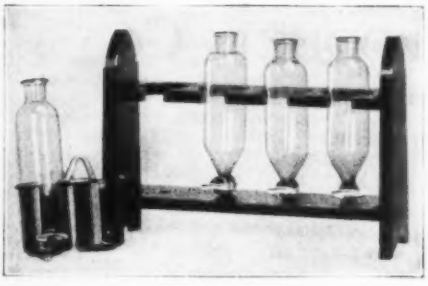

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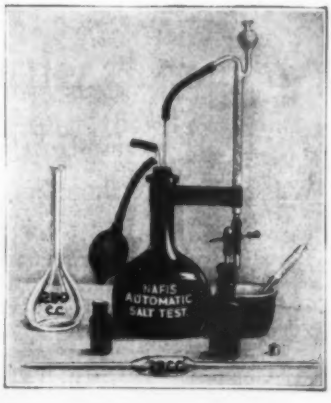

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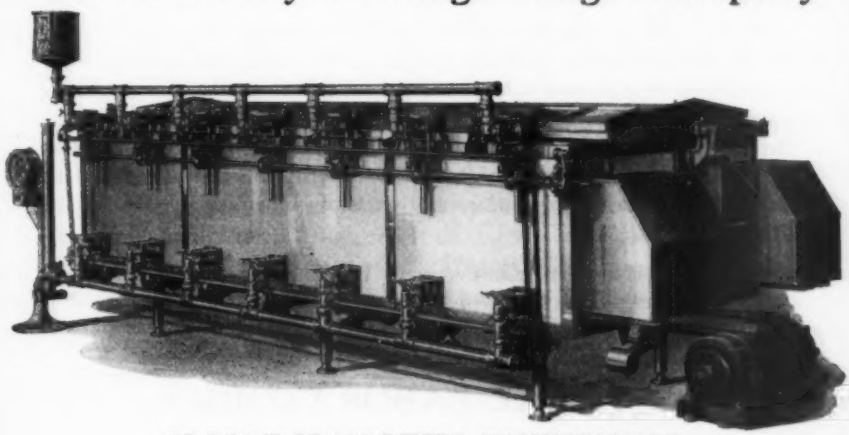

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Dairy Cattle Breeding Investigations, Bureau of Dairying, United States Department of Agriculture, Washington, D. C.

Recently there have appeared in the press such statements as the following: "Breeding production to production does not tend to result in further increase of productive capacity. It more often ends disastrously. It is now recognized by a steadily increasing number of leading breeders that the scales and Babcock test, great as have been their contributions to dairy advancement, can not safely serve alone in directing breeding plans."

There can be no question that breeding production to production, in the sense that this method of mating has been commonly followed, has not always brought desirable results. Inheritance for producing capacity has been gauged by breeders by the individual production record of a cow. If a bull is the son of a cow with a high record and is mated to a cow with a high record, this is breeding production to production and it is thought by many that the progeny of the mating should be a high producing animal. Frequently the results of this type of mating have been disappointing and have led to such statements as the one quoted. The difficulty is, that in the interpretation of the results of such matings, consideration has not been given to the fact that the inheritance of all animals for any given character, such as producing capacity, is double in its nature—that is, it has a double origin. Each individual possesses an inheritance for each character received from each parent, though outwardly the individual may for some features or characters show great resemblance to one parent, and in other features or characters show more marked resemblance to the other parent. Nevertheless, the individual does possess and will transmit an inheritance for each feature or character received from each parent, though it may be visible or

* Received for publication May 10, 1925.

first place it is not meant to imply that all the ancestral sires in four generations are proved. If the sire of the individual in question is definitely proved, no further attention need be paid to his ancestry. It is possible for this sire to be homozygous for the inheritance determining high production and yet for both of his parents to be heterozygous in their hereditary makeup for the factors controlling producing capacity. In Jersey cattle, for example, spotting is recessive to solid color. We may have two solid-colored parents that carry the recessive factor for spotting and from these parents we may get calves at different matings that are (1) homozygous for spotting and are therefore spotted; (2) homozygous for solid color and are therefore solid color; or (3) heterozygous in their inheritance for color and spotting, but are of solid color, possessing and transmitting, however, the inheritance for both solid color and spotting, as were the parents. Therefore, if either the sire or dam is once definitely proved to be homozygous for the character desired, there is nothing to be gained, insofar as that particular character is concerned, by consideration of the ancestry.

The second generation sire to be considered would be the sire of the dam, and the third generation sire to be considered would be the sire of the maternal granddam and so on. In the accompanying chart only the sires that need be considered, providing they are proved, are shown. If each of these sires be homozygous for factors determining high producing capacity and if each has the same combination of factors, the only opportunity for the individual in question to have received recessive factors must have come through the maternal great granddam, granddam and dam. So that in speaking of four direct generations of proved sires we are actually referring to only one sire in each ancestral generation.

The second qualification is in the statement that each of these sires is proved to be homozygous for the hereditary factors determining high-producing capacity. To determine that a sire is homozygous for factors determining high-producing capacity is not as simple as it may appear. If a bull is heterozygous in the factors determining producing capacity and is mated with

cows that are also heterozygous, some three-fourths of the daughters would be good or high producers and one-fourth poor producers.

If a sire is homozygous for the recessive factors determining low producing capacity and is mated with cows that are homozygous for dominant factors determining high-producing capacity, all the daughters should be good producers; they will be heterozygous in their inheritance, however, and will transmit low production to half their offspring. If a sire is mated with good cows it is a difficult matter to determine his hereditary makeup. A very large number of daughters from such matings would be required before his transmitting ability can be determined. It would seem that the best way to prove a sire would be to mate him with low-producing cows. Ordinarily, the low-producing cow would be homozygous for recessive factors determining low production unless she had some organic trouble that prevented the expression or fulfillment of her inheritance for high production. In the present stage of our breeding operations, when most cows are probably heterozygous for their inheritance governing producing capacity, a bull's hereditary makeup should probably not be estimated from the producing capacity of less than six daughters. As more cows become homozygous in their hereditary makeup for the dominant factors governing high-producing capacity, it will become more difficult to prove sires in such manner as to be certain of their being homozygous for dominant factors determining high producing capacity. Another factor that adds to the difficulty in determining the hereditary makeup of an advanced register or register of merit sire is the fact that breeders do not test the poor daughters of a sire due perhaps to not wanting the unfavorable publicity that such a record would bring, and due also to the high requirements for advanced registry and register of merit. As our testing of purebreds is handled to-day a sire that is homozygous for recessive factors determining low production, if mated to a few cows that are homozygous for dominant factors determining high production, and if only such daughters as are from these homozygous cows are tested, may acquire a reputation for being a great sire, whereas if the records of his poor

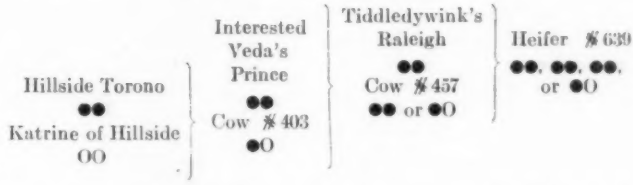
daughters from poor cows were published it would give a more accurate indication of his real hereditary makeup. Certainly, breeding animals could be more intelligently selected if all records, whether good or poor, were published.

If the theory is correct that the use of proved sires for generation after generation will produce a strain that will be homozygous for dominant factors determining high production, then this same theory offers a method for the selection of bull calves that will prove to be prepotent sires.

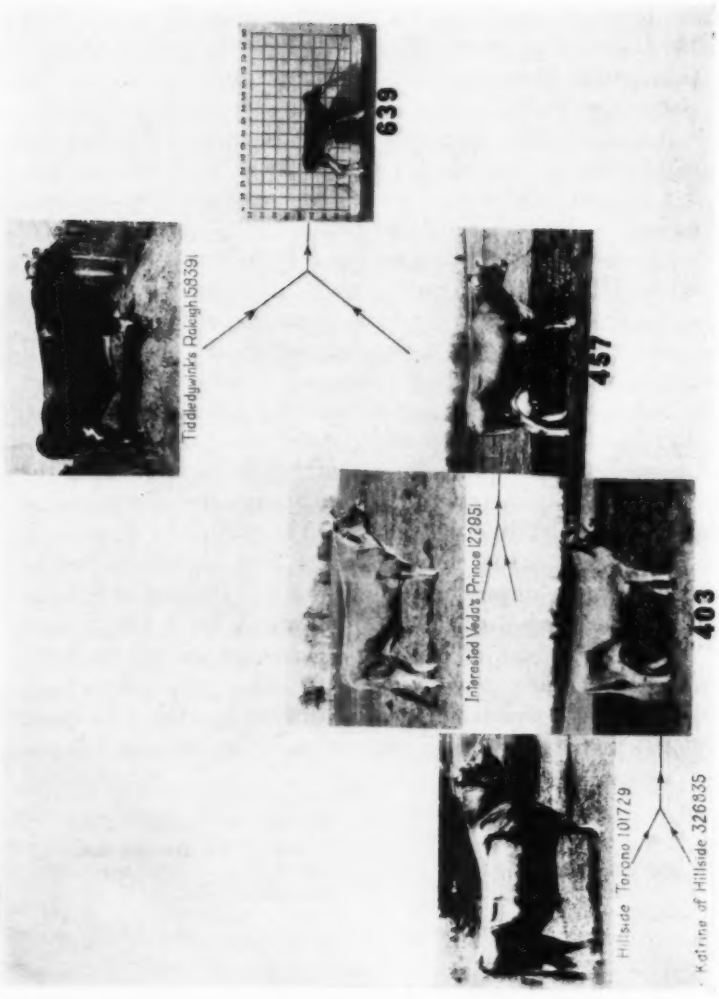
So far as we know no attempt has been made to determine how many factors are concerned in the inheritance governing producing capacity. Perhaps the stimulation to secrete milk may be a simple inheritance. The good dairy cow may vary from the poor-producing cow only in that she has this greater stimulation to secrete milk. Does the dairy cow have a different capacity for the assimilation, digestion and conversion of large amounts of nutrients, in the form of grains and roughage, into dairy products than the beef animal that produces a limited amount of milk? Or is it all in this one difference, the stimulation to convert nutrients into milk, or the stimulation to convert nutrients into meat? (Certainly the cow will not be a greater producer than is permitted by the strength of her weakest link in the chain of essential functions of the organs entering into the scheme of digestion, circulation and secretion.) In the herd of the Oregon Agricultural College several years ago were four full sisters, daughters of a noted sire. Three of the daughters made good records, but the fourth daughter seemed incapable of making one. On the death of this daughter it was found that she had a leaky heart valve. Perhaps this daughter had the same inheritance for producing capacity as did her three full sisters but because of this organic defect she could not utilize this inheritance to the fullest extent.

Since the number of factors entering into the determination of producing capacity is not known, no accurate prediction can be made as to the probability of securing an animal that is homozygous for the factors determining high-producing capacity, as a result of three or four generations of proved sire matings. If we

assume that the stimulation to secrete milk is the variable characteristic that causes the difference in producing ability between the high-producing and the low-producing cow and if we further assume that practically all cows have the digestive capacity to consume, digest and assimilate large amounts of nutrients for the production of large amounts of milk and butterfat, and have the constitution that will enable them to withstand the consequent tax on their physiological makeup, we could, perhaps, predict the results of several generations of proved sire matings. Let us assume, for purpose of illustration, that producing capacity in dairy cows is controlled by the intensity of the stimulation for secretion and that this is controlled by a single pair of factors. Refer to the chart showing three generations of proved sire matings and let us see what the chances are for this heifer calf being homozygous for a high-producing capacity. If all three of the sires whose pictures appear on this chart are homozygous for the factors determining a high-producing capacity, any recessive factors for low production that might be a part of the hereditary makeup of this heifer calf must come from the maternal great-grandam, Katrine of Hillside. The picture of Katrine of Hillside does not appear on this chart, but she was mated to Hillside Torono and produced the cow 403. Katrine of Hillside has no record and we know nothing about her. Let us first assume that Katrine of Hillside is homozygous for recessive factors determining low production. The open circle will indicate the recessive factor for low production, the solid circle the dominant factor for high production. The pedigree follows:



Thus we see that cow 403 is heterozygous for the factors determining producing capacity; that the chances are equal for cow 457 being either homozygous for the factors determining high produc-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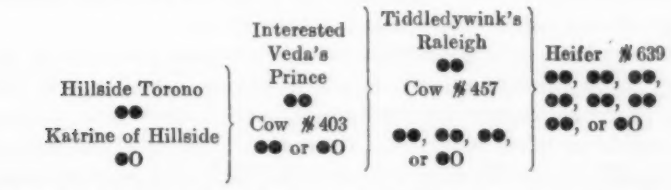
Tiddledywink's Raleigh 58391
457
Interested Veda's Prince 122851
403
Hillside Torono 101729
Katrine of Hillside 326835

FIG. 1

tion or heterozygous for factors determining producing capacity; that the chances are 3 out of 4 for heifer 639 to be homozygous and 1 out of 4 for her to be heterozygous.

Let us assume that Katrine of Hillside is heterozygous for factors determining producing capacity and see how this may affect the chances of heifer 639 for being homozygous for factors determining high producing capacity.



Thus it will be seen if Katrine of Hillside is heterozygous for the factors determining producing capacity, and if these three sires are all homozygous for the factors determining high producing capacity, heifer no. 639 has 7 chances out of 8 of being homozygous for factors determining high producing capacity. These calculations were made solely on the basis of the inheritance for producing capacity being a simple inheritance controlled by one set of factors. We know that such may probably not be the case, but we do not know how many factors are involved or have a bearing on the ultimate producing capacity. However, when a sire is transmitting uniformly high-producing capacity to his daughters, no matter how many factors are concerned, then we can safely assume that he must be homozygous for the dominant factors concerned, else his daughters would not be uniformly high producers. Therefore, we believe that this serves as an illustration of a method for breeding for a pure line in high production and also as a means of selecting young bulls.

There is one other phase of inheritance in milk and butterfat-producing capacity that should be briefly discussed. Wherever there has been a cross between two distinct breeds of dairy cattle that have a considerable difference between their milk flow and range of butterfat percentage, such as the Holstein-Friesian cross on Guernseys or Jerseys, it has been observed that the

resulting progeny have a milk flow and a percentage fat that is intermediate between the two parents. In these crosses the inbred F_2 generation has not shown a segregation of characters such as might be expected. This, together with a common belief of live stock breeders that a sire and a dam have a certain level of producing capacity and that the progeny will have a producing capacity that will represent an average of the parental levels, has led to a belief that the inheritance for milk and butter-fat-producing capacity is a blending inheritance.

In the crosses between two distinct breeds there are probably so many independently inherited factors having a bearing on the milk flow and percentage fat in each parent that it is almost impossible to bring about in any limited number of animals a segregation of factors that will result in the exact reappearance of either of the parental characteristics, or of the desired combinations of the characteristics of the two parents. According to Coulter,[1] if two races of corn were crossed in which one parent had large grains, but those were few in number, and the other parent had small grains but many in number, the F_1 progeny would have grains intermediate in size and number. Now if the F_1 plants were inbred in the hope of obtaining a combination of the two extremes of large and also numerous grains, and if there were five factor pairs that influenced these quantitative characters in each case, in order to secure the desired pure type from this cross of two parents, each having five pairs of factors influencing their respective desired character, it is estimated that 100 acres of corn would have to be grown in order to have an even chance of securing one plant having the desired combination.

While in crosses between breeds having markedly different hereditary makeups as to such characters as milk flow and percentage fat, the following generations do seem to possess an intermediate milk flow and percentage fat, yet there is not the same evidence in crosses within a breed. No average or intermediate production such as is found in the crosses between distinct breeds will be found in the production records of the

[1] Coulter, "Outline of Genetics."

daughters of a single sire and their dams. The production records of the purebred daughters of an individual sire will be quite variable and cover a considerable range. A high record daughter may come from a low-producing dam and a low-producing daughter may come from a high-producing dam, or from two dams of approximately the same producing capacity may come daughters with records that vary widely. We have explained in this paper how that may very well come about through the

TABLE 1

An example of a prepotent sire

DAUGHTERS			DAMS			DIFFERENCE		
Milk	Fat		Milk	Fat		Milk	Fat	
pounds	*per cent*	*pounds*	*pounds*	*per cent*	*pounds*	*pounds*	*per cent*	*pounds*
14,191.8	5.09	724.7	8,219.7	5.85	482.3	+5,971.9	−0.76	+242.4
12,869.4	5.35	690.3	8,503.1	4.63	385.3	+4,366.3	+0.72	+305.0
11,153.6	4.81	537.2	7,728.9	5.09	393.2	+3,424.7	−0.28	+146.0
11,190.8	5.79	635.6	9,079.8	5.83	521.4	+2,111.0	−0.04	+114.2
9,522.9	4.85	462.2	6,979.8	5.72	389.3	+2,543.1	−0.87	+72.9
9,133.7	5.59	498.7	8,918.4	4.59	410.4	+215.3	+1.00	+83.3
Ave. 11,343.7	5.25	591.5	8,238.3	5.29	430.3	+3,105.4	−0.04	+161.2
Percentage increase or decrease.....						+37.69%	−0.76%	+37.46%

The records of the daughters of this sire appear in the columns on the left and at the right of each daughter's record is the record of the dam. This sire increased the milk producing capacity of each daughter. The per cent fat of the daughters was decreased in all but two cases, but the decrease in per cent fat was not sufficient to offset the increase in milk and consequently every daughter showed an increase yield of butterfat.

dominant factors for high production and recessive factors for low production and the double nature of each individual in its hereditary makeup. In this discussion we have used the expression high and low producing capacity as illustrating extremes. There is need of further explanation, however, concerning the reason why some prepotent sires consistently raise the producing level of daughters coming from dams having records of 500, 600 and 700 pounds butterfat. (See table 1, showing records of daughters of prepotent sire and their dams.) The most logical

explanation would seem to be that of the cumulative or multiple factor hypothesis. The cumulative factor hypothesis explains variations in quantitative inheritance such as height, yield, number of rows of grain on ear of corn, length of ear, etc. The theory is that quantitative characters are produced by cumulative factors—a factor that when added to another similar factor, affects the degree of development of that character. The theory is illustrated by Correns[2] experiment in crossing red and white strains of Mirabilis. Instead of the F_1's being red as was expected, they were pink; intermediate between red and white. When these pink—F_1's—were interbred a ratio of 1 red : 2 pink, 1 white was secured, the explanation being that a single dose of the determiner for red gives pink, while when the F_1's were interbred a double dose of the red determiner gave red. Similarly, varying degrees of redness in wheat were secured in experiments at the Swedish Experiment Station[3] in which wheat with red and white kernels were crossed, the degree of red in the crossbred kernels depending upon the number of doses of red received.

An interesting case[4] of an intermediate result in crossing two varying characters was secured by Phillips in crossing two breeds of ducks—Rouens and Mallards—of different sizes. The Rouens were more than twice as heavy as the Mallards. The F_1 birds were intermediate in weight between the Rouen and Mallard parents, and due to the number of independent factors influencing the weight the F_2 birds did not segregate, but were also intermediate in weight, though more variable than the F_1 birds. None of the F_2 birds were as heavy as the Rouens, nor as light as the Mallards.

Punnett and Bailey[5] crossed two breeds of fowls differing widely in weight. The weight of the F_1 birds was much closer to that of the larger parent breed than to that of the smaller parent breed. This was taken to mean that one or more of the factors influencing large size showed dominance. Extreme variants

[2] Correns, C., Die neuen Vererbungsgesetze, Berlin, 1912.
[3] Nilsson, Ehle, Bot. Notiser 1908.
[4] Jour. Exper. Zool., 12, 1912; ibid., 1914.
[5] Journal of Genetics, 4, 1914.

were scarce in the F_2 generation, due to the small number of birds raised, but the F_3 birds had a great variation in weight, covering the ranges of both parent breeds. Individuals representing the extremes of the F_3 variants were mated and broods secured which averaged larger than the large parent, and smaller than the small parent. The interpretation was that there were four independent factors having among themselves unequal influence on the total weight; that when none of these factors were present birds of the minimum size were secured. Recombinations which included all four factors produced a race larger than the large parent. Similarly, recombinations which included the four allelomorphs of these factors produced a race smaller than the smaller parent. It was also assumed that two of the four hypothetical factors exerted a greater influence on total size than the remaining two factors.

Coulter says that the results of such experiments are in accord with the Mendelian method of inheritance, only two assumptions being necessary: (1) that dominance is absent, two doses having twice the effect of one; (2) that the independent similar factors are cumulative in their operation.

. . . . In connection with the cumulative factor concept, a modifying statement should be made as to the mechanism involved. Heretofore it has been assumed that we are dealing with numerous, separately inherited factors, absolutely identical in their nature, cumulative in their effect. No doubt one might regard with suspicion such a seemingly artificial mechanism.

Probably it would be easier to believe if it were modified in the following manner. Instead of assuming that the numerous factors are identical in function, we may assume that each factor has its own peculiar function, but that the function plays a part, directly or indirectly, in developing the quantitative character in question. For example, suppose height is the character. One of the factors determines the development of numerous nodes; another increases the amount of chlorophyll; another determines the size and vigor of the root system; another brings early germination and a long growing season. Such factors, although not identical, will be cumulative in increasing the height of the plant. Of course, a single dose of one type of factor may not bring the same increase in height as would a single dose of one of the other types, and therefore the mathematics of the situation will be slightly modified.

Applying the cumulative factor theory to producing capacity of milk and butterfat, if we assume that the presence of eight pairs of cumulative factors was necessary for the complete expression of an 800 pounds butterfat producing capacity, an animal with only four pairs of cumulative factors would have a producing capacity varying about the 400 pounds butterfat mark. If a sire were found that was homozygous for the eight factors necessary for an 800 pounds butterfat capacity and he were mated with heterozygous cows having enough of these cumulative factors to permit a 400 pounds butterfat capacity, then if the animals resulting from this mating were inbred, animals would be secured that would have producing capacities ranging from 400 to 800 or more pounds butterfat. This would seem to be in accord with what actually does happen in breeding work.

The great problem that has to be faced by the man who would breed uniformly high producing cattle, is that the hereditary material controlling producing capacity with which he must work is not purified or standardized. In order to make definite progress he must know the purity of the material with which he is working. The producing capacity of an individual cow is not a sufficient guide as to the purity of her germinal plasm for producing capacity, but the producing capacity of a number of daughters of a sire, especially if they be out of dams of known low producing capacity does give us a measure of the purity of the germinal plasm of the sire in regard to this character. It would seem to make little difference whether the theory of complete dominance or the theory of cumulative factors be followed. It is still the exceptional prepotent sire that offers to us the most rapid means of purifying the inheritance of our dairy cattle for high producing capacity. Coulter says: "We now know that individual variations are not always mere fluctuations or responses, but may be due to varying doses of cumulative factors. A selection on this basis may very well result in a new race that breeds true; and a race that breeds true is De Vries' definition of a new species." And so by the use of proved prepotent sires for generation after generation we may finally breed dairy cattle that will breed true for a high milk and butterfat producing capacity.

THE APPARENT DIGESTIBILITY OF LOW PROTEIN RATIONS BY DAIRY COWS*

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Continuing an investigation previously reported (1) a metabolism experiment was conducted with four Holstein-Friesian cows. The continuation was planned primarily with regard to the metabolism of minerals, which phase of the work is reported elsewhere (2): To these articles the reader is referred for further information regarding the cows; also regarding the details of the experimental methods.

The behavior of these animals with respect to the digestibility of the ration seemed worthy of record and is here presented.

The present experiment continued for two periods of 18 days each, which were separated by an interval of 12 days. Each 18-day period was divided into three 6-day sub-periods for each of which separate samples of milk, excreta and refuse were prepared. As the figures for the separate sub-periods agreed well with each other, only the average figure enters into this discussion.

The ration used is shown in table 1. It had a nutritive ratio of approximately 1:11; and contained approximately 70 per cent as much true protein and 158 per cent as much net energy as called for by Armsby's Standard (3); and 76 per cent of the digestible crude protein and 134 per cent of the digestible carbohydrates and fat called for by Haecker's Standard (4).

Cows 146 and 154 had been used in our previous experiments and had been receiving low protein rations very similar to those employed in the present work for several months. Cows 163 and 203, on the other hand, were taken shortly before the beginning of the present experiment from the regular herd where they had received pasture in season and an abundant supply of protein. Each of the cows was producing approximately 30 pounds milk per day at this time.

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TABLE 1

Amount of feed supplied in daily ration; analysis and average coefficients of digestibility analysis stated in percentage

KIND OF FEED	AMOUNT FED	DRY MATTER	AVERAGE DIGESTIBILITY COEFFICIENT	CRUDE PROTEIN	AVERAGE DIGESTIBILITY COEFFICIENT	ETHER EXTRACT	AVERAGE DIGESTIBILITY COEFFICIENT	CRUDE FIBER	AVERAGE DIGESTIBILITY COEFFICIENT	ASH	NITROGEN-FREE EXTRACT	AVERAGE DIGESTIBILITY COEFFICIENT
	pounds											
Wheat bran	3.25	90.30	0.65	14.75	0.78	3.90	0.68	10.21	0.31	7.13	54.31	0.72
Ground corn	6.50	88.25	0.90	9.31	0.74	3.16	0.93	2.05	0.57	1.20	72.53	0.94
Ground oats	3.25	91.65	0.70	12.69	0.78	3.33	0.87	11.77	0.35	3.73	60.13	0.81
Dry beet pulp	9.80	90.30	0.75	8.81	0.52	0.40	0.90	19.16	0.83	2.85	59.08	0.83
Cane molasses	1.30	73.90	0.78	2.69	0.32					5.09	66.12	0.90
Timothy hay I	10.50	87.26	0.55	3.71	0.48	1.47	0.50	32.51	0.50	3.96	45.62	0.62
Timothy hay II	10.50	86.72	0.55	4.22	0.48	1.35	0.50	31.35	0.50	4.15	45.65	0.62
Refuse		95.75		3.27		0.33		46.10		4.46	41.59	
Total nutrients supplied	I	30.622		2.784		0.633		6.140			19.873	
	II	30.556*		2.827*		0.621*		6.018*			19.876*	
Digestible nutrients	I	21.472		1.790		0.483		3.579			15.835	
	II	21.436*		1.811*		0.477*		3.518*			15.837*	
Calculated digestibility, entire ration	I	70		64		76		58			80	
	II	70		64		77		58			80	

* The supply of nutrients for cow 203 in period II was 95 per cent of these values.

The sole difference in the treatment of the cows during the two periods of the experiment was in the kind of water supplied. One of each pair of cows, as indicated above, received distilled water and the other well or tap water during period I. In period II the kind of water supplied each cow was reversed.

The rations were well consumed but there was a small amount of refuse consisting mostly of the coarse stems of weeds which occurred as an impurity in the hay. This refuse was carefully saved and analyzed. The total amount for the four cows during the 36 days was only 3 pounds of air-dry material. Although the results have been calculated taking full account of these values, they do not enter into the present report because they merely

TABLE 2

Constituents of average daily feces

COW	PERIOD	WEIGHT OF FECES	WEIGHT OF AIR-DRY MATTER	DRY MATTER	CRUDE PROTEIN	ETHER EXTRACT	CRUDE FIBER	NITROGEN-FREE EXTRACT
146	I	82.99	12.098	11.495	1.301	0.386	3.189	5.061
146	II	81.47	12.166	11.575	1.334	0.390	3.313	5.522
154	I	69.95	11.307	10.722	1.263	0.412	3.464	5.435
154	II	75.53	11.988	11.365	1.338	0.392	3.363	5.556
163	I	71.83	10.626	10.072	1.273	0.376	2.964	4.667
163	II	83.26	11.562	11.001	1.337	0.420	3.148	5.206
203	I	89.13	12.349	11.725	1.391	0.429	3.289	5.705
203	II	92.94	12.354	11.655	1.311	0.386	3.287	5.693

introduce another complication without materially affecting the outcome.

The results are presented in a series of four tables. Table 1 deals with the amount and composition of the daily ration. Table 2 considers in like manner the amount and ingredients of the average daily feces. Table 3 shows the amount, also the per cent, of each ingredient of the ration apparently digested. As a part of table 3 the observed digestibilities are grouped with respect to the previous feeding of the cows; those from cows 146 and 154 whose feeding had not been changed being compared with those from cows 163 and 203, recently changed from a ration of widely different character. The observed differences

TABLE 3

Material apparently digested; observed percentages of digestibility

COW	PERIOD	DRY MATTER	PER CENT DIGESTED	CRUDE PROTEIN	PER CENT DIGESTED	ETHER EXTRACT	PER CENT DIGESTED	CRUDE FIBER	PER CENT DIGESTED	NITROGEN-FREE EXTRACT	PER CENT DIGESTED
D 146	I	19.127	62.5	1.483	53.3	0.247	39.0	2.951	48.1	14.812	74.5
T 146	II	18.941	62.0	1.493	52.8	0.231	37.2	2.705	44.9	14.354	72.2
T 154	I	19.900	65.0	1.521	54.7	0.221	34.9	2.676	43.6	14.438	72.7
D 154	II	19.145	62.6	1.489	52.7	0.229	36.9	2.655	44.1	14.320	72.0
D 163	I	20.550	67.1	1.511	54.3	0.257	40.6	3.176	51.7	15.206	76.5
T 163	II	19.515	63.9	1.490	52.7	0.201	32.4	2.870	47.7	14.670	73.8
T 203	I	18.897	61.7	1.393	50.0	0.204	32.2	2.851	46.4	14.168	71.3
D 203	II	17.373	60.0	1.374	51.2	0.235	34.6	2.731	42.5	14.183	69.9
146 and 154, average (continuous low protein cows)			63.0		53.4		37.0		45.2		72.9
163 and 203, average, (regular herd cows)			63.2		52.1		35.0		47.1		72.9
Tap water average			63.2		52.6		34.2		45.7		72.5
Distilled water, average			63.0		52.9		37.7		46.6		73.2

in digestibility are so small that they lack significance in view of the unavoidable errors attending such work.

The results are also grouped with reference to the kind of water with which the cows were supplied. It should be noted in this connection that practically the same amount of each kind of water was consumed. Here again, the observed digestibilities are close and show no significant difference which can be ascribed to the influence of the kind of water used.

In table 4, the observed digestibilities are arranged for comparison with those calculated by the use of average coefficients (14). Striking differences are at once evident, the observed

TABLE 4

Comparison of digestibilities

		DRY MATTER	CRUDE PROTEIN	ETHER EXTRACT	CRUDE FIBER	NITROGEN-FREE EXTRACT
1	Observed digestibility from table 3.....	63.1	52.8	36	46.1	72.9
2	Calculated digestibility from table 1.....	70	64	76	58	80
3	Relation of observed to calculated digestibility, per cent:					
	This experiment (1÷ 2).....	90	82	47	80	91
4	Wide ration cows 1921–1922.....	94	88	70	87	96
5	Narrow ration cows, 1921–1922.....	95	94	89	90	99
6	Cow 154, 1922, experiment.....	94	91	66	88	94
7	Cow 154, present, 1923–1924 experiment.....	91	84	47	76	90

digestibilities being lower in every case. In the third line the observed digestibilities are expressed as per cents of the calculated.

In lines 4 and 5 are give like figures taken respectively from the cows receiving wide and those receiving narrow rations in our previous work (1). Lines 6 and 7 give like data for cow 154 for the 1922 and the present experiment, respectively. The percentages are smaller, or in other words, the discrepancies between calculated and observed digestibilities were larger for each ingredient of the ration in the present experiment.

In both our experiments the greatest depression of digestibility occurred with the ether extract. Ellett and Holdaway (5) have

observed depressions of digestibility accompanying the use of a wide or high-energy ration, which in the average are much greater than any we have observed. In their case the ether extract was less affected than any of the other ingredients. Their observations were made on cows producing only small amounts of milk.

Ellett, Holdaway, and Harris (6) have conducted extensive digestion experiments on dairy cows. The results of individual experiments fluctuated considerably but the mean apparent digestibility of the entire basil ration was about 3 per cent below that calculated from average figures. The addition to the ration of 1 pound starch increased this discrepancy to five per cent. A similar addition of 1 pound Black Albumin to the basil ration brought the observed to a practical equality with the calculated digestibility, and the authors conclude from this evidence that the addition of protein to a basil ration increases the digestibility of same. This coincides in a general way with the older view as expressed by Armsby (7) and Kellner (13). For the narrow ration cows in our earlier experiment (1) (see also line 5 in table 4) the observed digestibility was considerably below the calculated, even though all the cows were receiving an excess of protein and the ration of one of them had a nutritive ratio of 1:2.

Eckles (8) also reported digestibilities considerably below the calculated for his cows during liberal feeding and production on a ration carrying an abundant supply of protein; though the same cows fed a reduced amount of the same ration when dry appeared to digest more than the calculated amount.

The "Black Albumin," probably a dried blood preparation, used by Ellett, Holdaway and Harris in these experiments belongs to that group of highly digestible animal protein feeds, such as milk in its various forms, meat meal, tankage, fish meal, etc., various members of which have been shown to possess superior nutritive qualities (9) and to affect marked increase in the digestibility of rations of which they form a part (10); and some of which in experiments where digestibility was not determined have been shown to be more efficient milk producers than the usual high protein feeds of vegetable origin (15) (16). Dried

blood is not a common ingredient of dairy rations and in view of our own results and those of Eckles we are obliged to question whether a like increase in digestibility would have been obtained by the addition of a like amount of protein from the usual sources. Indeed the digestibilities observed by Ellett and Holdaway (5) on their extreme high protein rations, from vegetable sources only, were not on a par with the calculated values.

The depression of digestibility observed in the present experiment was considerably greater than that which occurred in the case of cow 154 in the 1922 work (1) although the nutritive ratio of the two rations was the same, 1:11, indicating that some other influence aside from the amount of protein was at work. The chief points of difference between the two rations was that in 1922, 4.5 pounds clover hay was fed while no clover was used in the later work. The 1923–1924 ration contained 1.3 pounds cane molasses and 3.25 pounds oats not found in that of 1922. The difference may likely have been due to the specific influence of one of these feeds. Suspicion at once points to the cane molasses as the feed responsible for this depression of apparent digestibility, for Lindsey and Smith (11) working with sheep observed regular and consistent depression in the digestibility of rations of hay, hay and corn meal, and hay and gluten feed when cane molasses in varying amounts was added. The depression, however, was not proportional to the amount of molasses fed. Williams (12) has very recently reported somewhat irregular depressions in the digestibility of dairy rations resulting from the rather liberal use of molasses. He considered the molasses as 100 per cent digestible, hence did not include the nutrients supplied by the molasses along with the other food in calculating the digestibilities of the total ration. Had these values for the molasses been included the depressions in digestibility for the entire ration would have been greater.

Kellner (13) reviewing the work of numerous European investigators regarding the depression of digestibility caused by the addition of carbohydrates such as, starch or sugar, suggests the following possible causes which would apply equally well in case of molasses.

The depression in the digestibility of protein is commonly attributed to the increase in nitrogen excretion via the intestines which always accompanies an increase in food, even of nitrogen-free food.

Other causes are suggested some of which may affect the protein as well as the other nutrients of the ration.

a. The following by the intestinal organisms of a kind of path of least resistance, by working on the easily fermentable material added rather than on the more resistant feed residues which they would otherwise attack.

b. The production of considerable amounts of lactic acid from the starch or sugar, lactic acid having an inhibitory effect on bacterial action.

Increased peristaltic action which does not allow sufficient time for the completion of the digestive process has also been suggested as a probable cause, although this could not be verified by Lindsey and Smith (11).

Our data do not afford any further explanation as to the immediate cause of the depression as observed in our experiment, except that the depression of protein digestibility in case of cow 154 could hardly have been due to the presence of additional carbohydrates, for the nutritive ratio was the same in each experiment.

The data do, however, permit of an interesting comparison with respect to the ultimate effect of such apparent depressions in digestibility on the productive value of the ration.

In the case of cow 154 the ration used during the 1922 metabolism experiment as well as that used in 1923–1924 was representative of that fed during the entire course of the respective lactation periods. In the 1922 period a total of 6567 pounds digestible nutrients, figured from average coefficients, was consumed and a production of 9646 pounds milk containing 342 pounds fat recorded in 363 days, a production of 1.47 pounds milk containing 0.052 pound fat for each pound of digestible nutrients consumed.

In the succeeding lactation period on the ration having a much lower apparent digestibility as shown in table 4 she consumed

7818 pounds digestible nutrients figured by average coefficients and produced 11,793 pounds milk containing 364 pounds fat in 366 days, a production of 1.51 pounds milk containing 0.047 pound butterfat for each pound of digestible nutrients consumed. Values very close indeed to those found in the previous period.

Since there was no marked difference in the condition of the animal at the close of these respective lactation periods, it would seem reasonable to conclude that in this case the depression in apparent digestibility was not accompanied by a corresponding decrease in the productive efficiency of the ration.

CONCLUSIONS

1. No marked difference in the digestibility of a very low protein ration was observed between cows long accustomed to the ration and others which had been recently transferred from a ration containing a liberal supply of protein.

2. The total consumption of water and digestibility of the ration were also unaffected by changing from well water to distilled water or vice versa.

3. The apparent digestibility of each ingredient of the ration, but more particularly of the ether extract, was much lower than the digestibility as computed by the use of average digestion coefficients.

4. In the one instance where a comparison is possible a considerable depression in the observed digestibility did not result in decreased efficiency of the ration.

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THE BACTERIAL CONTENT OF ICE CREAM*

A REPORT OF EXPERIMENTS IN BACTERIAL CONTROL IN SIX COMMERCIAL PLANTS

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INTRODUCTION

The work herein reported is a continuation of the studies on bacterial control in ice cream. In a previous publication (1) it was shown that it was possible to produce consistently ice cream containing less than 100,000 bacteria per gram, and methods for producing ice cream of low bacterial count were prescribed. These methods have also been described in popular form in a special circular (2).

The work outlined in this paper was conducted with two purposes in mind, first, to learn what the average ice cream plant was doing in bacterial control; and second, to show the improvement which could be effected by following prescribed methods. It was also wished to strengthen further conclusions drawn in previous reports.

PLAN OF EXPERIMENT

Selection of plants. Six ice cream plants were selected for the work. Selection of these plants was based on capacity, plant conditions, railway facilities, and type and quality of raw materials used.

Methods. The senior author supervised the work in the plants while the junior author handled the bacterial analysis at the station laboratory. Four days were spent in each plant. A mix was made each day, thus the experiments in each plant, with one exception, cover four mixes. No change was made during the first two days in the usual methods employed in the plant. The

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second two mixes in each plant were supervised, including the entire process from washing and sterilizing equipment to the freezing of the ice cream. Faulty methods noted during the first two days were corrected wherever possible.

Sampling. Milk thieves, glass stoppered sample bottles, spoons, and butter triers, were wrapped in paper, sterilized and shipped to the plants. The samples were packed in a regular ice cream packing can with ice and salt, and shipped to the laboratory by express. The samples consequently arrived at the laboratory in a frozen condition. Since all samples received the same treatment the results are comparative even though the freezing may have reduced the counts to some extent.

Samples were taken with sterile milk thieves except the samples "after homogenizing," "after cooling," and "after freezing" which were caught directly in sterile bottles. The "after hardening" sample was taken at the same time and in the same manner as the "after freezing" sample but was held in a frozen condition for an additional twenty-four hours. Samples of dry materials were taken with sterile spoons. Butter was sampled with a sterile trier and transferred to a bottle with a sterile spoon.

The ingredients were all sampled before adding them to the mixing vat. Owing to the presence of undissolved milk powder, gelatin, or butter it was not always possible to obtain a representative "before pasteurizing" sample before the mix reached a bacteria killing temperature. Therefore, to insure uniformity, all "before pasteurizing" counts are calculated from the counts on the ingredients used in preparing the mix (see tables 1 and 5). The "after pasteurizing" sample was obtained from the mixing vat at the time the homogenizer was started. Time and temperature records of pasteurization were taken from the moment the mix reached its maximum temperature until the homogenizer was started.

The "before homogenizing" sample was taken from the mixing vat after about three-quarters of the mix had run out. It required from thirty to seventy-five minutes for three-fourths of the mix to run through the homogenizer and since the temperature was maintained, that portion of the mix still in the vat when the

"before homogenizing" sample was taken had in reality been subjected to pasteurizing temperature for an additional thirty to seventy-five minutes. This accounts for the frequent marked reduction in counts between the "after pasteurizing" and "before homogenizing" samples. This method was followed because it would give evidence of the minimum count which part of the mix reached and also made it possible to note the effect of homogenizing on the counts without the contamination which might take place from the homogenizer itself. The "after homogenizing" and "after cooler" samples were taken at approximately the same time as the "before homogenizing" sample, the former immediately after passing through the homogenizer and the latter immediately after passing over the cooler. The "after cooler" sample therefore does not indicate the true sanitary condition of the cooler, since considerable mix had washed over it and undoubtedly removed much of the contamination before the sample was taken. The "before aging" sample was taken from the aging vat after the entire mix had been cooled to aging temperature. It therefore included the contamination from the aging vat. The "after aging" sample was taken just before the first batch was run into the freezer.

The "after freezing" and "after hardening" samples were taken from the first batch of mix frozen in the cleaned freezer.

Bacteriological methods. The bacteriological analyses were made on a gravimetric basis. The purpose of using a gravimetric sample was to overcome the variation in volumetric samples of melted ice cream resulting from incomplete exhaustion of air, and the adherence of melted ice cream to the pipettes. In order to make the counts made at various stages comparable, ten grams were weighed under aseptic conditions for all of the various samples as well as the finished ice cream. The counts, therefore, represent the number of bacteria per gram. The determination of total numbers of bacteria was made according to the plate method recommended by the American Public Health Association. Liebig's beef extract and Difco peptone were used in the preparation of the agar.

EXPERIMENTAL RESULTS

Since the conditions in the six plants were very different, no two employing identical methods, it seems more desirable to discuss each plant separately, later bringing all the results together in a summary. The plants are not listed in the order visited and, for obvious reasons, their identity is not disclosed.

PLANT I

Plant I was a comparatively small plant manufacturing approximately 40,000 gallons of ice cream annually.

Equipment. A 200-gallon horizontal mixing vat,[1] a 100-gallon per hour homogenizer,[2] a tubular cooler, a 50-gallon starter can and a 40-quart horizontal brine freezer comprised the equipment. This apparatus was connected with sanitary pipe and fittings with the exception of the outlet from the mixing vat which was a galvanized iron pipe, globe valve combination. About 10 feet of galvanized iron pipe with a globe valve conveyed the mix from the starter can to the freezer. The mix was aged in 10-gallon milk cans.

Raw materials. The mix was compounded from the following materials: raw whole milk, received daily from the producers; unsalted butter; a fair grade of skimmilk powder; cane sugar; and a good grade of gelatin. Table 1 gives the bacterial counts on the ingredients used. The whole milk ranged in count from 1,100,000 to 5,200,000 bacteria per gram; the butter from 11,000 to 152,000 per gram; the skimmilk powder, 320,000; the gelatin, 13,000; and the sugar, 240 bacteria per gram.

Cleaning and sterilizing methods. The equipment was carelessly washed with hot water and washing powder and no effort was made to sterilize the vats and freezer. The homogenizer was not taken apart but was washed by pumping a part of the water from the vat through it and over the cooler. After the cooler had been left as clean, milky fluid was still visible in places on it.

[1] This vat was also used for pasteurizing sour cream for buttermaking.

[2] The name "homogenizer" will be used to indicate all machines used for the purpose of homogenizing regardless of trade name.

TABLE 1

The bacteria count per gram of the ingredients

PLANT NUMBER	MIX NUMBER	CREAM	WHOLE MILK	SKIM MILK	CONDENSED MILK	MILK POWDER	BUTTER	GELATIN	SUGAR	WATER
I	1		1,100,000			320,000	135,000	13,000	240	
	2		1,730,000			320,000	152,000	13,000	240	
	3		1,910,000			320,000	11,000	13,000	240	
	4		5,200,000			320,000	20,200	13,000	240	
II	5	8,600,000		6,650,000	272,000			7,000	180	
	6	2,400,635		2,880,000	91,000			7,000	180	
	7	4,230,000		1,740,000	91,000			7,000	180	
	8	3,230,000		314,000	1,160,000			7,000	180	
III	9	580,000	60,000,000			418,000		550	20	
	10	4,170,000	22,000,000			418,000		550	20	
	11	555,000	11,800,000			418,000		550	20	
	12	1,860,000	22,900,000			418,000		550	20	
IV	13	975,000	23,314,000		11,800,000			13,400	120	
	14	1,110,000	56,800,000		15,400,000			91,000	120	
	15	168,000	18,500,000		60,000			91,000	120	
	16		3,490,000		7,600		15,500	91,000	90	
V	17	374,000	750,000		166,000			800	70	16
	18	5,590,000	6,100		143,000			800	70	16
	19	1,240,000	15,800		2,390,000			800	70	
VI	20	9,930,000	1,280,000			160,000	280,000	11,300	180	245
	21	30,400,000	5,960,000			160,000	1,810,000	11,300	180	245
	22	6,900,000	2,750,000			20,000	290,000	11,300	20	245
	23	32,000,000	3,660,000		92,300	20,000	211,000	11,300	20	245
Average.....		6,350,702	12,798,205	2,896,000	2,639,408	276,000	324,966	18,095	122	168

TABLE 2

The number of bacteria per gram of ice cream mix at various stages in the manufacturing process

PLANT	MIX	PASTEURIZATION					HOMOGENIZING		AFTER COOLING	AGING		AFTER FREEZING	AFTER HARDENING
		Time	Temperature	Before (calculated)	After	Per cent efficiency	Before	After—before cooling		Before	After		
I	1	30	147	797,615	4,300	99.461	580	1,100	12,600	89,000	81,000	320,000	145,000
	2	30	145	1,237,143	4,600	99.629	2,000	750	2,700	30,000	290,000	332,000	265,000
	3	30	147	1,372,810	2,250	99.837	1,900	3,000	1,700	8,200	16,500	118,000	91,000
	4	30	150	3,701,609	900	99.976	460	830	900	4,000	4,300	98,000	32,500
II	5	0	145	5,411,512	546,000	89.911	231,000	875,000	834,000	671,000	700,000	688,000	769,000
	6	20	142	4,615,657	123,000	97.357	208,000	398,000	441,000	385,000	692,000	660,000	546,000
	7	30	145	3,206,057	66,900	96.969	19,500	30,300	62,000	72,200	74,800	70,000	39,000
	8	30	150	1,553,257	28,000	98.198	22,700	16,300	20,000	43,500	28,500	23,700	6,200
III	9	16	145	34,657,705	10,700	99.970	14,300	17,000	16,000	31,000	39,000	84,000	100,000
	10	15	145	13,713,505	3,000	99.980	3,100	3,000	4,300	9,700	12,400	56,000	48,000
	11	30	147	6,939,288	2,200	99.968	1,600			2,300	2,800	4,400	3,200
	12	30	150	13,277,805	57,000	99.570	10,000	21,500		21,100	21,900	22,000	17,000
IV	13	5	145	15,520,085	868,000	94.400	322,000	227,000	443,000	244,000	528,000	1,507,000	1,253,000
	14	40	145	35,273,679	850,000	97.591	325,000	401,500	474,000	89,000	98,000	275,000	238,000
	15	30	150	10,768,303	125,000	99.583	45,000	54,000	18,500	80,000	88,000	97,000	57,000
	16	30	145	2,164,758	29,200	98.652	3,900	5,300	4,900	13,400	20,000	64,000	73,000

TABLE 2—*Continued*

V	17	20	165	430,900	2,000	99.536	2,100	8,200		29,700	13,000	17,400	47,600
	18	20	165	1,755,011	2,100	99.880	2,600	2,400		3,500	8,200	10,500	11,100
	19	20	165	804,868	4,500	99.441	19,400	39,500		50,800	70,000	102,000	79,000
VI	20	0	144	2,916,086	500,000	82.854	30,300	80,000	70,300	940,000	910,000	950,000	680,000
	21	0	145	12,773,900	2,730,000	78.629	128,000	395,000	368,000	950,000	880,000	600,000	580,000
	22	30	149	2,760,647	21,500	99.221	2,800	7,600		30,800	27,000	26,400	17,500
	23	30	148	4,243,488	58,800	98.704	3,100	8,100		18,900	11,700	14,000	15,000
Average.....				7,821,551	262,606	96.643	60,840	117,971	173,368	165,970	200,743	266,947	222,308

The sanitary piping was slightly steamed. The cans in which the mix was collected from the cooler were washed in a vat of water which was not changed often enough and were then set over a steam jet for a few seconds, after which they were inverted on a rack. A stale odor was noticeable in most of the cans when taken down for use.

Processing the mix. The skimmilk powder, gelatin and sugar were added to the cold milk in the vat and heat applied at once. The butter was then added in about one pound pieces. When the mix reached pasteurizing temperature, which for this plant was 145°F., the ingredients were in solution or suspension. The mix was held at 145° for thirty minutes, after which it was homogenized without cooling, so that the last part of the mix was at bacteria killing temperatures for approximately one hour longer. After homogenizing, the mix was cooled to 66°F. by passing over the tubular cooler, and was collected in 10-gallon cans. The mix was spread on the cooler with a bottle brush which had been used in washing cans. The first can of mix was allowed to remain in the warm room until the last can was ready, after which they were placed, without further cooling or agitation, in a cold room at 38°F. Here they remained until the following morning when four or five cans were removed at a time, dumped into an elevated starter can, and cooled with brine to 40°F. preparatory to freezing. The average temperature of the mix when taken from the cold rooms was 50°F. From the starter can the mix flowed by gravity through a globe valve and galvanized iron pipe to the freezer.

Results

Unsupervised mixes. An examination of the data in table 2, mixes 1 and 2, will show a moderately high original count; over 99 per cent efficiency of pasteurization; and a normal increase due to homogenization. The counts from mix 1 indicate contamination from an improperly cleansed tubular cooler. It is also worthy of note that about 130 gallons of mix had washed over the cooler when the sample was taken.

No aging vat was available and since it was impractical to follow 15 individual cans of mix through the entire process,

the "before aging" sample was obtained from a composite taken from four cans by means of a sterile glass milk thief. The first, fifth, tenth, and fifteenth cans were selected as representative. Individual samples were also taken from each can and the counts are shown in table 3.

The figures in table 3 indicate that the cooler must have been responsible for much of the increase in numbers noted in the "before aging" sample, since the count of the first can increased from 4300 to 325,000. By the time the fifth, tenth, and fifteenth cans of mix had passed over the cooler the greater part of the contamination presumably had been washed off. It is probable that part of the increase noted above is due to the improperly sterilized cans.

TABLE 3

Contamination due to cooler

AFTER PASTEURIZING	FIRST CAN	FIFTH CAN	TENTH CAN	FIFTEENTH CAN	BEFORE HOMOGENIZING
4,300	325,000	24,000	7,800	4,600	580
	SAME CANS AFTER AGING				
	185,000	31,200	71,000	34,300	

Referring to table 3 it is noted that the counts on cans 5, 10 and 15 show a considerable increase after aging. Because of the manner in which the cans of mix were handled this increase was not unexpected. Can 1, however, shows a marked decrease probably due to experimental error, and as a result the averages recorded in table 2 show a slight decrease. That one of these counts is in error is further strengthened by the fact that the second day's mix (no. 2), produced under identical conditions, actually shows an increase from 30,000 to 290,000 instead of a decrease.

A poorly washed freezer further increased the counts while hardening resulted in a decrease.

Supervized mixes; methods and results. The second two mixes studied at plant I (table 2, mixes 3 and 4) show the results of improved methods of cleaning and proper cooling. In table 4 are recorded the averages for each two day period.

TABLE 4

The average counts for the first two days without supervision and for the second two days under supervision

PLANT NUMBER	DAYS	PASTEURIZATION			HOMOGENIZATION		AFTER COOLING	AGING		AFTER FREEZING	AFTER HARDENING
		Before	After	Per cent efficiency	Before	After		Before	After		
I	First two days	1,016,879	4,450	99.563	1,290	925	7,650	59,500	185,500	326,000	205,000
	Second two days	2,537,210	1,575	99.938	1,180	1,915	1,300	6,100	10,400	108,000	61,750
II	First two days	5,013,584	332,500	93.369	219,500	636,500	637,500	528,000	696,000	674,000	657,500
	Second two days	2,379,657	47,450	98.007	21,100	23,300	41,000	57,850	51,650	46,850	22,600
III	First two days	24,185,605	6,850	99.972	8,700	10,000	10,150	20,450	25,700	70,000	74,000
	Second two days	10,108,546	29,200	99.712	5,800			11,700	12,350	13,200	10,100
IV	First two days	25,396,882	859,000	96.618	323,500	314,250	458,500	166,500	313,000	891,000	745,500
	Second two days	6,466,530	77,100	98.808	24,450	29,650	11,700	46,700	54,000	80,500	65,000
V	First two days	1,092,955	2,050	99.813	2,350	5,300		16,600	10,600	13,950	29,350
	Third day	804,868	4,500	99.441	19,400	39,500		50,800	70,000	102,000	79,000
VI	First two days	7,844,993	1,615,000	79.414	79,150	237,500	219,150	945,000	895,000	775,000	630,000
	Second two days	3,502,067	40,150	98.854	2,950	7,850		24,850	19,350	20,200	16,250
Average...	First two days	10,758,566	470,308	95.629	105,748	200,745	266,590	289,341	354,300	458,325	390,225
	Second two days	4,617,535	36,022	99.220	11,850	18,643	18,000	31,381	33,227	58,136	39,127

Since steam was not available for sterilizing purposes hot water was used. In the morning before making the mix the vat was filled one-third full of water and with the covers tightly closed was heated by means of the revolving coil to 180°F. This hot water was then pumped by means of the homogenizer through the piping and over the cooler, using a clean brush to spread the water over the cooler. More care was also observed in steaming the cans. The ice cream maker was instructed to wash the starter can and freezer by a similar method, since the supervisor could not be present.

No changes were recommended in the handling of the mix with the exception of cooling. After all the mix had passed over the cooler it was dumped back into the mixing vat and cooled to 40°F. with circulating ice water. The mix was then drawn off into the original cans, which were placed in the cold room (38°F.) for twenty-four hours. While this was a laborious method of handling the mix it demonstrated the importance of proper cooling as a factor in bacterial control.

Again referring to the data in tables 2 and 4 it is evident that exceedingly efficient pasteurization and comparative freedom from equipment contamination were attained, the average count "before aging" being only 6100 bacteria per gram for the second two days as compared to 59,500 bacteria per gram the first two days. The results from mix 3 show an increase from 8200 to 16,500 during aging while in mix 4 the increase is only from 4000 to 4300. Probably the increase in no. 3 during aging should be checked to experimental error since the aging temperature was as low as in mix 4.

An abnormal increase is noted in both mixes 3 and 4 "after freezing" probably due to failure on the part of the ice cream maker to wash the freezer as instructed.

The average final counts for the two days with supervision was 61,750 bacteria per gram compared to 205,000 bacteria per gram without supervision.

PLANT II

Plant II manufactured about 10,000 gallons of ice cream annually. The mixes averaged about 2000 pounds.

Equipment. A rather unusual and therefore very interesting condition was found in plant II, it being the only plant studied in which galvanized iron pipe and fittings and globe valves were used exclusively for conveying the mix. The equipment included a 300-gallon horizontal mixing vat, two 300-gallon aging vats, a 200-gallon per hour homogenizer, a tubular cooler, two small pumps, and two 40-quart horizontal brine freezers. A 200-gallon vat and a small tubular cooler were used for pasteurizing and cooling sweet cream.

Raw materials. The sweet cream used was received from the producers in small amounts and was of uncertain quality. The cream was heated to about 125° to 130°F. for a few minutes and then cooled in order to keep the cream sweet until ready to make the mix. The raw cream ranged from 31 million to 50 million bacteria per gram before heating and from 2,400,000 to 8,600,000 bacteria per gram after heating. The skimmed milk used was purchased from a local milk pasteurizing plant and was supposed to have been pasteurized. The counts ranged from 214,000 to 6,650,000 bacteria per gram. The counts on the plain condensed skimmed milk used varied between 91,000 and 1,160,000 bacteria per gram. The gelatin contained 7000 bacteria per gram and the cane sugar 180 bacteria per gram.

Cleaning and sterilizing methods. Since the piping was all of galvanized iron with globe valves, it was not practical to disconnect it for cleaning. The mix conveying pipes were fitted with water and steam connections. After use, cold water was run through the pipes lines followed by hot water and finally by steam under slight pressure. The homogenizer and pumps were not taken apart but, while still running, were washed and steamed in the same manner as the piping. After the vats were washed with warm water, but without washing powder, they were steamed until the temperature exceeded 200°F. The entire system was again steamed before starting the mix the next morning. The tubular cooler was rather carelessly washed, the use of insufficient water and brushing leaving a milky fluid to dry between the tubes. The mix was pumped from the aging vat to the freezers. As previously mentioned, the pump was not taken apart for cleaning.

The freezers were well washed with an abundance of hot water and steamed for five minutes.

Processing the mix. The entire mix was pasteurized. It was evident that the workman had the wrong conception of what was meant by pasteurization at 145°F. for thirty minutes, since the homogenizer was started as soon as the mix reached 145°F. After the mix had been running through the homogenizer for thirty minutes, that remaining in the vat was cooled to 120°F. In mix 6 the aging vat was not ready to receive the mix, consequently it was held at an average of 142°F. for twenty minutes and cooled to 110°F. after the homogenizer had been running ten minutes.

From the homogenizer the mix was conveyed through about 30 feet of piping to the tubular cooler where it was cooled to 62°F. Cooling to 35°F. was completed in the vat. The temperature did not exceed 45°F. during aging. The aging period was eighteen to twenty hours.

Results

Unsupervised mixes. Since pasteurizing was carelessly handled the efficiency was low; namely, 89.91 and 97.35 per cent respectively in the two mixes studied. The increases in bacterial count recorded in table 2 at certain stages in the processing indicate considerable contamination from equipment. But for the nature of the piping and the fact that there were traps in the lines to which the water and steam could not gain access, one would expect, considering the methods employed in steaming, freedom from contamination. Since the freezers were properly washed the average counts "after aging," 696,000, and "after freezing," 674,000 show no increase at this point.

It sometimes happened that one aging vat was full and the other only partly emptied when quitting time came. As a result it was impractical to wash the conveying pipe leading from the vat. Such a condition occurred while the supervisor was present. The mix in vat 2 was not all frozen when it came time to quit. The vat valve was closed. Cold water was then admitted to the line and pumped through the freezers. This was followed with

TABLE 5

Showing the per cent of the total count due to each ingredient and the per cent composition of the mix

PLANT NUMBER	MIX NUMBER	CREAM		WHOLE MILK		SKIM MILK		CONDENSED MILK		MILK POWDER		BUTTER		GELATIN		SUGAR		WATER	
		Per cent composition	Per cent bacteria count	Per cent composition	Per cent bacteria count	Per cent composition	Per cent bacteria count	Per cent composition	Per cent bacteria count	Per cent composition	Per cent bacteria count	Per cent composition	Per cent bacteria count	Per cent composition	Per cent bacteria count	Per cent composition	Per cent bacteria count	Per cent composition	Per cent bacteria count
I	1			69.69	96.11					4.90	1.96	11.28	1.90	0.40	0.006	13.73	0.003		
	2			69.60	97.33					4.90	1.26	11.27	1.38	0.49	0.005	12.72	0.002		
	3			71.00	98.77					4.84	1.12	11.15	0.09	0.40	0.003	12.61	0.002		
	4			70.84	99.52					4.71	0.40	11.32	0.06	0.37	0.001	12.73	0.0008		
II	5	33.36	53.02			37.60	46.20	15.16	0.76					0.40	0.0006	13.43	0.0004		
	6	33.05	76.66			36.88	23.01	16.26	0.32					0.48	0.0007	13.32	0.0005		
	7	38.24	73.31			33.01	26.00	14.94	0.67					0.48	0.001	13.34	0.001		
	8	39.40	81.95			30.96	6.25	15.76	11.78					0.47	0.002	13.39	0.001		
III	9	25.00	0.41	57.50	99.54					3.04	0.03			0.37	0.000005	14.06	0.000008		
	10	25.02	7.61	57.53	92.30					2.99	0.09			0.37	0.00001	14.09	0.00002		
	11	25.03	2.00	57.58	97.82					3.00	0.18			0.30	0.00003	14.08	0.00003		
	12	26.56	3.72	55.77	96.19					3.07	0.09			0.37	0.00001	14.19	0.00002		
IV	13	18.48	1.17	58.91	88.34			13.77	10.47					0.55	0.0005	8.26	0.00006		
	14	19.57	0.61	57.98	93.36			13.78	6.01					0.52	0.001	8.13	0.00002		
	15	19.57	0.30	57.98	99.61			13.78	0.07					0.52	0.003	8.13	0.00008		
	16			61.93	99.92			12.45	0.04			10.08	0.07	0.55	0.02	14.23	0.0005		

TABLE 5—*Continued*

V	17	32.15	27.91	37.50	65.28			17.64	6.77					0.45	0.0006	10.29	0.001	1.96	0.00006
	18	30.87	98.34	38.43	0.13			18.63	1.52					0.44	0.0002	10.35	0.0004	1.25	0.00001
	19	27.97	43.09	42.20	0.81			18.88	56.07					0.40	0.0004	10.47	0.0008		
VI	20	26.68	90.87	19.62	8.61					5.73	0.31	1.96	0.18	0.62	0.002	14.28	0.0008	31.08	0.002
	21	39.35	93.66	12.38	5.76					6.25	0.07	3.47	0.49	0.61	0.0005	14.05	0.0002	23.86	0.0004
	22	22.65	65.62	34.36	34.23					5.64	0.04	0.96	0.10	0.62	0.002	14.05	0.0001	18.11	0.001
	23	11.03	83.20	18.51	15.95			16.97	0.37	2.62	0.01	9.14	0.45	0.50	0.001	7.33	0.00004	33.87	0.0002

TABLE 6

Bacteria added to each gram of mix by various ingredients

PLANT NUMBER	MIX NUMBER	CREAM	WHOLE MILK	SKIM MILK	CONDENSED MILK	MILK POWDER	BUTTER	GELATIN	SUGAR	WATER	TOTAL COUNT
I	1		766,640			15,700	15,200	50	25		797,615
	2		1,204,225			15,686	17,137	63	32		1,237,143
	3		1,356,000			15,500	1,230	50	30		1,372,810
	4		3,684,150			15,094	2,286	49	30		3,701,609
II	5	2,869,700		2,500,500	41,255			33	24		5,411,512
	6	3,538,800		1,062,000	14,800			33	24		4,615,657
	7	1,618,000		574,000	14,000			33	24		3,206,057
	8	1,273,000		97,200	183,000			33	24		1,553,257
III	9	145,000	34,500,000			12,700		2	3		34,657,705
	10	1,044,000	12,657,000			12,500		2	3		13,713,505
	11	138,750	6,788,125			12,409		2	2		6,939,288
	12	494,000	12,771,000			12,800		2	3		13,277,805
IV	13	183,000	13,711,000		1,626,000			75	10		15,520,085
	14	217,319	32,933,734		2,122,138			479	9		35,273,679
	15	32,891	10,726,656		8,268			479	9		10,768,303
	16		2,161,617		946		1,674	509	12		2,164,758
V	17	120,300	281,300		29,290			3	7	0.3	430,900
	18	1,726,000	2,300		26,700			4	7	0.2	1,755,011
	19	346,861	6,668		451,328			4	7		804,868
VI	20	2,650,077	251,177			9,167	5,494	70	25	76	2,916,086
	21	11,964,478	736,370			10,000	62,900	69	25	58	12,773,900
	22	1,811,600	945,000			1,130	2,800	70	3	44	2,760,647
	23	3,530,864	677,000		15,668	524	19,292	56	1	83	4,243,488
Average.....		1,872,480	7,166,313	1,058,425	377,782	11,100	14,223	94	14	43	7,821,551

warm water and then given a thorough steaming. It is at once evident that part of the line could not be cleaned. Also the steam heated the mix in the vat behind the valve. The following morning a sample was taken from vat two after agitating and then a five gallon batch was pumped into the receiving tank on the freezer where another sample was taken after stirring with a sterile milk thief. These counts were respectively 360,000 and 506,000 bacteria per gram, which means that the first quart of mix pumped through the line carried contamination to the extent of approximately 3 million bacteria per gram.

Supervised mixes: methods and results. Extraordinary efforts were made on the supervised mixes (table 2, mixes 7 and 8) to reduce the counts obtained in the unsupervised work. A careful check of contaminating traps in the pipe lines was made. The pipe lines and cooler were flushed with water containing washing powder and this was followed with a considerable volume of hot water. The usual methods of steaming were used. The homogenizer was taken apart, cleaned and re-assembled when wanted for use.

Mix 7 was pasteurized at 145°F. for thirty minutes and mix 8 at 150°F. for thirty minutes before the homogenizer was started. Homogenization was performed at the pasteurizing temperature.

The average pasteurizing efficiency on the supervised mixes was 98 per cent. The reason for this efficiency not exceeding 99 per cent is probably due to the previous, though inefficient, pasteurization of the cream and skimmed milk. Contamination from equipment was slight and the final average count of the hardened ice cream was 22,600 bacteria per gram as compared to 657,500 bacteria per gram on the previous two day test.

The results in plant II demonstrate that it is possible, though difficult, to produce ice cream with a low bacterial content even where galvanized iron piping and globe valves are used. However, considering the danger of high counts inherent in such piping it cannot be recommended. There is also a possibility that under some conditions galvanized iron piping might be a contributing factor in the production of metallic flavors.

PLANT III

Plant III was a comparatively small plant in rather poor condition.

Equipment. A 200-gallon horizontal mixing vat, an 80-gallon homogenizer, two 200-gallon aging vats, a champion cooler, and a horizontal brine freezer comprised the equipment. The mix was conveyed through sanitary piping. The lining of the mixing vat was in poor condition and the coil was badly warped due to freezing. There was a broken gauge on the homogenizer.

Raw materials. The mix in this plant was made from fresh milk and sweet cream with a small amount of skimmilk powder to balance the solids. The whole milk was of questionable quality averaging 30,675,000 bacteria per gram. Most of the milk was warm when received. The sweet cream was skimmed from a part of the whole milk, pasteurized, and used the following day, the counts then ranging from 555,000 to 4,170,000 bacteria per gram. The skimmilk powder contained 418,000; the gelatin 550, and the sugar 20 bacteria per gram.

Methods of cleaning and sterilizing. The method of washing at the end of the day was as follows: The vat was washed with warm water but no washing powder. This water was pumped through the homogenizer and sanitary piping. The piping was not brushed or taken down. The freezer was washed in a similar manner. Nothing except the sanitary piping was steamed and it only slightly. An examination of the equipment after it was supposedly clean and ready for use revealed the presence of a green scum on sanitary fittings and valves, and the walls and coil in the mixing vat were found to be greasy.

In the morning, before using, the homogenizer was taken apart and flushed out with water. After re-assembling, about 2 quarts of a hypochlorite solution was pumped through the homogenizer and piping, over the cooler, and into the aging vat. The vat gate was left open so the hypochlorite solution drained out immediately. Hypochlorite solution was also splashed onto the sides of the vat with a bottle brush.

Processing. The mix, with the exception of the sugar, was

pasteurized at 145°F. for fifteen minutes, cooled to 120°F. and homogenized. There was no water in the champion cooler, it being used simply as a part of the conveying system. From this cooler the mix passed into the aging vat through a very rusty funnel, containing a piece of greasy copper screen. The sugar was added in the aging vat and the mix cooled to 35°F. The mix was usually aged about twenty to twenty-four hours.

Results

Unsupervised mixes. The results secured in this plant were rather a surprise. They show that insanitary conditions and careless pasteurizing do not always mean high counts, although they usually do.

The average count of the mix before pasteurization (table 4) was 24,185,605 bacteria per gram. After pasteurization, the count was 6850; 99.972 per cent efficiency being obtained with a temperature of 145°F. for only fifteen minutes. As previously noted, the cream and milk were of very poor quality and were handled under poor conditions. The failure to keep the cream and milk cool, together with the warm weather which prevailed were conducive to a bacterial flora dominated by organisms of the colon group. Although no determination of the number of organisms of the colon type was made, it was noted that the predominating colonies on the plates were characteristic of colon colonies. Since the organisms of this group are very easily killed by heat it may account, in part at least, for the unexpected reduction in bacteria as a result of the relatively inefficient method of pasteurization. It has been a common observation in this and in previous work that exceptionally high counts in the raw mix are frequently accompanied by nearly 100 per cent efficiency of pasteurization, and in nearly all instances the conditions are indicative of a high colon content.

Supervised mixes. Before the supervised mixes were made the cooler, funnel, and copper screen were discarded and the piping was rearranged to facilitate cleaning. After washing, all equipment, including the freezer, was thoroughly steamed. The homogenizer was taken apart and left apart until ready to use

the next day. After re-assembling, the hypochlorite solution was run through as before.

Pasteurization was changed from 145°F. for fifteen minutes to 150°F. for thirty minutes, and the homogenization was carried out at the pasteurizing temperature. The entire mix including the sugar was pasteurized.

The results (table 4, plant III) show a slightly lower pasteurizing efficiency than for the unsupervised mixes. The samples taken at the various stages show very little increase and the final count on the finished product was 10,100 bacteria per gram as compared to 74,000 in the unsupervised mixes.

PLANT IV

This plant was the largest one included in the experiments, the usual size mix being 4300 pounds.

Equipment. The equipment, consisting of a 400-gallon mixing vat, a 300-gallon per hour homogenizer, two 400-gallon aging vats, and a tubular cooler, was in excellent condition. There were about 30 feet of sanitary pipe and fittings between the mixing and aging vat and about 20 feet more from the aging vats to two horizontal brine freezers located on a lower floor.

Raw material. The whole milk used was fresh and slightly better in quality than that used in plant III. The cream was pasteurized cream which had been held at 34°F. for twenty-three to twenty-five days. The cream had an old, slightly bitter flavor and a bacterial content of 168,000 to 1,110,000 bacteria per gram. Mixes 13 and 14 were made from the same batch of cream. Mix 15 was made from cream several days older than above but lower in count, while in mix 16 no sweet cream was used. The unsalted butter used in mix 16 was freshly churned and of good quality. The sweetened condensed milk used in mixes 13 and 14 gave a very high count; viz., 11,800,000 and 15,400,000 bacteria per gram respectively. The sweetened condensed milk used in mix 15 contained 60,000, while the plain condensed skimmilk (a very sandy 40 per cent solids product) contained only 7600 bacteria per gram. The gelatin used the first day contained 13,400 bacteria per gram, while that used the last three days contained 91,000.

Methods of cleaning and sterilizing. The equipment was first rinsed with luke warm water and then washed with hot water (170° to 180°F.), washing powder and brushes. No steam was used for sterilizing, but instead the entire system was given a final rinse with about 50 gallons of hot water (170° to 180°F.). This rinse was repeated in the morning before making the mix. No attempt was made to sterilize the freezer. Water was allowed to stand in the lower trough of the cooler. The homogenizer was taken apart for washing.

Processing the mix. The entire mix was pasteurized. The pasteurizing in this plant was also rather uncertain, being 145°F. for five minutes on the first day and 145°F. for forty minutes on the second day. The longer time on the second day was not intentional but was due to the fact that the aging vat was not ready to receive the mix. The mix was homogenized at the pasteurizing temperature, cooled over the tubular cooler to 80°F., and further cooled with brine to 35°F. in the aging vat. During aging the temperature of the mix did not exceed 45°F. The mix was usually aged about twenty-four hours.

Results

Unsupervised mixes. An examination of the data secured from mixes 13 and 14 (table 2) reveals very high initial counts, 15,520,085 and 35,270,679 respectively. The efficiency of pasteurizing was 94.4 and 97.59 per cent, leaving an after pasteurizing count of approximately 850,000 bacteria per gram in each case. From this point on the counts were erratic but gave constant increases, especially between the "after aging" and "after freezing" samples, which increased from 528,000 to 1,507,000 in mix 13, and from 98,000 to 257,000 in mix 14, indicating considerable contamination from the freezer.

In connection with mixes 13 and 14 the following explanation is of interest. On the day the first experiment was started it was found that a mix was already in the process of preparation. Since another mix was to be made as soon as the first was finished, the second mix was chosen for the experiment. However, one sample was taken from the aging vat of the first mix. The count on this mix proved to be very low; viz., 2400 bacteria per gram.

The second mix was prepared without washing the equipment, the maker reasoning that since all the material which had just gone through the system was of a good quality there was no need for washing. The bacterial counts on the second mix were very high due to "pin point" colonies, presumably thermophilic bacteria (3). Similar results have been noted in the college ice cream laboratory. While the evidence is not conclusive it seems logical to believe that thermophilic bacteria are frequently present, though in such small numbers as to escape notice. Ordinarily thirty minutes pasteurization is insufficient time for noticeable growth. However, in this instance it is probable that growth began in the first mix and, since the equipment was not washed, resulted in heavy contamination of the second mix. With this heavy contamination noticeable growth was possible during the pasteurization of the succeeding mix. Since the same type of colony was also present in the mix made on the following day (no. 14) the wash water apparently was not hot enough to destroy the contamination. The inconsistency in the counts on these two mixes was due to the fact that the plates were crowded with these small "pin point" colonies, which rendered accurate determinations difficult to obtain.

Supervised mixes. All the equipment was thoroughly steamed in addition to the usual method of washing. As a result mix 15 contained considerably fewer "pin point" colonies. The equipment was again thoroughly steamed before mix 16 was prepared. The culture plates made from mix 16 were entirely free from "pin point" colonies.

Mixes 15 and 16 were pasteurized at 150° and 145°F. for thirty minutes, respectively. The initial counts in these mixes were lower than in nos. 13 and 14. The pasteurizing efficiency was high and contamination from equipment fairly low. The average final count on the second two days was 65,000 bacteria per gram as compared to an average of 745,500 bacteria per gram for the first two days.

This experience furnishes further proof that even under extremely difficult conditions it is possible to produce ice cream of low bacterial count if thorough cleaning and sterilizing methods

are used, and where pasteurization is carried on in accordance with the Kansas law. The statutes of Kansas stipulate that all dairy products used in the manufacture of ice cream be pasteurized at not less than 145°F. for not less than thirty minutes.

PLANT V

This was one of the larger plants visited. The mixes averaged about 3000 pounds.

Equipment. The equipment consisted of a 400-gallon horizontal pasteurizing vat, a 300-gallon per hour homogenizer, a 400-gallon vertical glass enameled aging tank, and two 40-quart horizontal brine freezers. There were about 100 feet of sanitary piping between the mixer and the aging tank and about fifteen feet between the aging tank and the freezers.

Raw materials. The fresh milk and cream used at this plant were much lower in bacterial counts than that received at the other plants visited. The cream was pasteurized at an outlying station and shipped to the ice cream plant. The cream averaged 2,401,000 bacteria per gram. The milk, surplus from a bottling plant, averaged 257,300 bacteria per gram with a range of 6100 to 350,000 bacteria per gram (table 1). The plain condensed skimmilk counts varied between 143,000 and 2,390,000. The gelatin contained 800 bacteria per gram.

Methods of cleaning and sterilizing. The washing of vats, sanitary piping, and freezers was done in an approved manner. The homogenizer was not taken apart. No steam was used for sterilizing but instead the entire system was flushed with a home-made calcium hypochlorite solution. The glass lined aging tank was sterilized by dashing the hypochlorite solution down the sides.

Processing the mix. The entire mix was pasteurized at a temperature of 165°F. for twenty minutes after which it was cooled to 120°F. for homogenizing. The mix was cooled with brine to 35°F. in the aging tank.

Results

Unsupervised mixes. An examination of table 2, mixes 17 and 18, reveals that the average bacterial content of the mix was lower

in this plant than in the others studied, probably due to the superior quality of milk and cream used. A pasteurizing efficiency of 99.53 and 99.88 per cent respectively reduced the bacterial counts to 2000 per gram. A temperature of 165°F. for twenty minutes would be expected to kill a larger percentage of the organisms than is ordinarily obtained at 145°F. for thirty minutes, but there seemed to be no practical advantage in such extreme pasteurization. In most instances equally as high efficiency has been obtained with 150°F. for thirty minutes (1). It is more costly to pasteurize at 165°F. and there is always some danger of a cooked flavor, although none was noticed in these trials.

Contamination from equipment was low, indicating that the homemade hypochlorite solution was fairly efficient as a sterilizing agent. The final counts on the two mixes were 47,600 and 11,100 bacteria per gram.

Supervised mixes. Plant V was the only plant studied where the unsupervised mixes were consistently lower in count than the supervised. It should be remembered that conditions as a whole were unusually good in this plant. A study of the methods indicated only two places for improvement; namely, taking the homogenizer apart to clean after use, and steaming equipment in place of using the hypochlorite solution as a sterilizing agent. In cleaning the homogenizer it was found necessary to use a knife to remove the accumulated "milk stone" from the valves.

An examination of the results obtained from mix 19[3] reveals a gradual increase in counts in each step of the process after pasteurization. At first this might appear to be due to contamination from the equipment. It is believed, however, that the increases are probably due to the development of thermophilic bacteria at the temperature of homogenizing (120°F.). This contention is supported by two facts: (*a*) the culture plates contained types of colonies not ordinarily encountered; and (*b*) the 400 per cent increase in counts between the "after pasteurizing" and the "before homogenizing" samples, under conditions which precluded the possibility of contamination. As previously

[3] The supervisor was able to be present for only one mix.

explained, a period of about one hour elapsed between the time these two samples were taken. It would be unfair therefore to conclude from these results that the homemade hypochlorite is more efficient than steam as a sterilizing agent.

PLANT VI

Plant VI was a small plant with old equipment in poor condition and manned by poorly trained workmen. The boiler was in such poor condition that one and one-half hours time was required for heating the 1300 pound mixes to 145°F.

Equipment. The equipment consisted of a 200-gallon mixing vat, two similar aging vats, a tubular cooler in extremely bad condition, a rebuilt homogenizer, and two 40-quart horizontal brine freezers. Sanitary pipe and fittings were used.

Raw materials. The cream used averaged 19,807,000 bacteria per gram and was invariably slightly sour. The milk, freshly delivered averaged 3,410,000 bacteria per gram. The milk powder gave counts varying from 20,000 to 160,000 and the butter from 211,000 to 1,810,000. The gelatin contained 11,300 bacteria per gram.

Methods of cleaning and sterilizing. The vats and sanitary piping were washed with warm water (130°F.) and washing powder, and then rinsed with warm water but not steamed. The homogenizer was taken apart and washed but no attempt was made to sterilize it. The freezers were carelessly washed by rinsing with cold water, luke warm water and washing powder, and again rinsed with cold water, the head being removed and left off until the next freezing. Upon examination a scum was found around the fruit hopper seat.

Processing the mix. The entire mix consisting of milk, cream, butter, skimmilk powder, sugar, and gelatin was heated to 145°F. and the homogenizing immediately started. The temperature during homogenization varied from 145°F. at the beginning to 120°F. at the end. From the homogenizer the mix passed over the tubular cooler which reduced the temperature to about 80°F. The cooling was not started in the vat until the entire mix had been homogenized; the coil remaining stationary. Since it

required one and one-half hours time to homogenize, a part of the mix was held at 80°F. in a poorly washed vat for about two hours. The mix was eventually cooled to 35°F. and frozen after six to ten hours aging.

Results

Unsupervised mixes. As would be expected from the foregoing description of the methods, the pasteurizing efficiency was low (82.85 and 78.63 per cent in the two mixes) and gross contamination from equipment resulted in final counts of 680,000 and 580,000 bacteria per gram.

Supervised mixes. Between the unsupervised and supervised mixes, a new boiler was installed and the sanitary piping was rearranged so as to eliminate the cooler, which as mentioned above was in very poor condition.

The equipment was washed according to approved methods and steamed. Hot water at 180°F. was pumped through the homogenizer and since no steam connection was available for steaming the freezer, it was also scalded with water at 180°F.

With the new but inadequate boiler installed it still required fifty-five minutes to heat the mix to 145°F. The mix was held for thirty minutes before starting the homogenizer. The temperature was maintained above 140°F. during the entire homogenizing process. The mix ran directly into the aging vat and cooling was started as soon as the mix reached the coils.

Table 2, mixes 22 and 23, with final counts of 17,500 and 15,000, or an average of 16,200 bacteria per gram as compared to an average of 630,000 bacteria per gram in the unsupervised mixes, show practically no contamination from equipment.

INGREDIENTS AS A SOURCE OF BACTERIA IN THE ICE CREAM MIX.

In all previous work on bacteria in ice cream the liquid milk products have been recognized as the chief source of bacteria in ice cream.

Table 5 shows clearly the source of the bacteria in the ice cream mixes studied in this work insofar as ingredients are concerned. The data here presented very forcibly emphasize the

importance of the liquid milk products as the principal sources of bacteria in ice cream. Examination of the data shows that where cream and milk were used, they together, were responsible in most instances for over 99 per cent of the bacteria before pasteurization. This fact suggests the desirability of more effort on the part of the manufacturer toward securing milk and cream of better quality. In only one of the plants (plant V) was milk used which would pass the most liberal city ordinance for milk that was to be pasteurized.

The condensed milk in one case supplied 56 per cent of the total bacteria in the unpasteurized mix. In another case highly concentrated unsweetened condensed skimmilk (40 per cent solids) contained only 7600 bacteria per gram. Thus, while it made up 12.45 per cent of the total weight of the mix it was responsible for only 0.04 per cent of the total organisms before pasteurization (plant IV, mix 16). The milk used in this mix contained 3,490,000 bacteria per gram and supplied 99.92 per cent of the total bacteria. Butter was used in only a few mixes and in the majority accounted for less than 1 per cent of the bacteria present. Attention is called to the fact that gelatin has been a negligible factor as a source of bacteria in the ice creams studied. The same thing may be said of water and sugar.

In table 6 there is recorded the calculated number of bacteria added to each gram of mix by the various ingredients. It will be noted that cream added from 32,000 to nearly 12,000,000 bacteria to each gram of mix, with an average of almost 2,000,000. Milk added from 2300 to more than 34,000,000 and averaged a little over 7,000,000 per gram.

This table also indicates that condensed milk when used as the source of additional solids is a more potent source of bacteria in the mix than skimmilk powder when used for the same purpose. The condensed milk added from less than 1000 in one case to more than 2,000,000 in another case or an average of 377,668 bacteria per gram of mix. The skimmilk powder added from 1130 to 15,700 or an average of only 11,100 bacteria per gram of mix. In mix 23 the skimmilk powder added only 524 bacteria

per gram but since only 34 pounds were used in a 1300 pound mix in contrast to 220 pounds of sweetened condensed milk in the same mix, it should be disregarded.

On first thought the above facts may seem of more importance than they really are. However, it should be remembered that condensed milk reduces to a considerable degree the bulk of the fluid milk needed in the mix. As shown in table 1 milk usually contains more bacteria per gram than the condensed milk. It is therefore evident that unless water is used in place of fluid milk in conjunction with milk powder the reduction in count due to using milk powder rather than condensed milk is of little consequence in the production of ice cream of low bacterial count. This is especially true where the entire mix is pasteurized. The condensed milk used was the product of three condenseries. The milk powder was obtained from three different sources. In eight mixes (5, 6, 7, 8, 16, 17, 18, 19) plain condensed milk was used while in four mixes (13, 14, 15, 23) sweetened condensed milk was used. The highest counts, viz., 11,800,000 and 15,400,000, were on sweetened condensed milk while the lowest, 7600, was on the heavy plain condensed milk. These results forcibly suggest the need of greater supervision of production on the part of the condenseries making bulk goods. The results also indicate considerable room for improvement in some milk powder factories.

The other ingredients butter, gelatin, water, and sugar were responsible for relatively few organisms.

SUMMARY AND CONCLUSIONS

One of the objects of this investigation was to determine the possibility of producing a product of unquestioned sanitary quality under the most trying plant conditions, and to verify the results obtained in previous work. Table 4 emphasizes the results very well. The average count for all the unsupervised finished ice cream was 390,225 bacteria per gram, while the average for the supervised finished ice cream was only 39,127 bacteria per gram. If the results obtained in plant V are not averaged with the rest, the difference would be even more pronounced. The highest count of the finished product under

supervision was 91,000 bacteria per gram while the lowest was 3200 bacteria per gram.

Only 5 of 12 unsupervised mixes were pasteurized as required by the Kansas law (mixes 1, 2, 14, 17, 18; table 2).

It is apparent from a study of tables 4, 5 and 6 that not enough effort is expended on the part of the manufacturers toward securing a more desirable quality of milk products.

The results included in this work verify in every detail the summary of the results of previous work (1).

From the data presented in this paper the following conclusions seem justifiable:

1. Cream and milk are the most important source of bacteria in the raw ice cream mix. In most instances these products supplied over 99 per cent of the total bacteria in the raw mix.

2. Condensed milk may, at times, be an important source of bacteria in the raw mix.

3. Gelatin, water, and sugar were negligible factors as sources of bacteria in the ice creams studied.

4. Thorough washing with an alkaline washing powder and sterilization of all equipment with live steam are essential factors in the production of ice cream of low bacterial content.

5. Carelessly washed tubular surface coolers are a considerable source of bacterial contamination in ice cream.

6. Conveying pipes, pumps, and homogenizers cannot be properly cleaned without being taken apart.

7. Hypochlorite solutions, when properly used, give satisfactory results in sterilizing ice cream plant equipment.

8. The use of pasteurizing equipment for two or more successive mixes without washing may result in high counts due to the growth of thermophilic bacteria.

9. The aging, without agitation, of improperly cooled mix (65°F.) in cans in a cold room (38°F.) results in a material increase in bacterial content in twenty-four hours.

10. Proper pasteurization is the most important factor governing the bacterial count of ice cream. Pasteurization at 145°F. for thirty minutes and homogenization at pasteurizing temperature results in counts of less than 100,000 bacteria per gram

in the finished ice cream, provided equipment contamination is reduced to a minimum. These results were obtained even with raw mixes containing as high as 34 million bacteria per gram.

11. If the bacterial flora of the mix is constituted of types easily destroyed by heat, high efficiency of pasteurization may be obtained in less time than is regularly prescribed.

12. Extreme pasteurizing temperatures (165°F.) are unnecessary in producing ice cream of low bacterial content.

13. Homogenization, even though contamination is negligible, usually results in an increased count, as determined by the plate method, probably due to breaking up of bacterial clumps.

14. Ice cream mix should be cooled as soon as possible after homogenizing, to prevent bacterial growth.

15. It is possible and practical to produce ice cream containing less than 100,000 bacteria per gram under all plant conditions, provided that efficient pasteurization is practiced, that the temperature is controlled during aging and that equipment is properly washed and sterilized. High bacterial counts indicate carelessness at some point in the manufacturing process which in turn indicates an undesirable, if not an unsafe, product. There can be no valid excuse for ice cream containing more than 100,000 bacteria per gram as determined by the plate method.

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BRIGHAM, ELBERT S.....St. Albans, Vt.
BRODY, SAMUEL.....Dairy Building, Columbia, Mo.
BROWN, R. W.....Agricultural College, Winnipeg, Canada.
BORLAND, A. A.....Dairy Department, State College, Pa.
BOUSKA, F. W.....1526 S. State Street, Beatrice Creamery Company, Chicago, Ill.

BUSH, M. G.....Cuba, N. Y.
BUTTON, F. C.....Agricultural Experiment Station, Dairy Department, New Brunswick, N. J.
BURDICK, HOWLAND.....Rhode Island State College, Kingsdon, R. I.
BRYAN, K. V.....Dairy Department, W. Lafayette, Ind.
BALTZER, A. C.....Dairy Department, E. Lansing, Mich.
BENNETT, FREDERICK W.....Dairy Department, Georgia State College of Agriculture, Athens, Ga.
BOYER, A. H.....New Haven Dairy Company, New Haven, Conn.
BIGELOW, A. P.....Middlesex, Vt.
BOUDEWYNS, CELESTIN.....R. R. No. 1, Box 145, Westwood, N. J.
BOEHR, J. W.....Dairy Department, Stillwater, Okla.
BRITT, A.....City Consumers' Company, Paducah, Ky.
BIERMAN, HARLOW.....Experiment Station, College Park, Md.
BROWN, HAMLIN L.....Extension Dairyman, Gainsville, Fla.
BURKE, A. D.....Dairy Department, Stillwater, Okla.
BENDIXEN, H. A.....Dairy Department, Moscow, Idaho.

CADE, L. S.....Climax Creamery, Shawnee, Okla.
CAINE, GEORGE B.....Logan, Utah.
CALDWELL, R. E.....Blatchford Calf Meal Company, Waukegan, Ill.
CAMPBELL, M. H.....Dairy Department, Urbana, Ill.
CAMPBELL, THEODORE A.....38 Little Street, Matawan, N. J.
CAVE, H. W.....Dairy Department, Manhattan, Kans.
CHUMLEA, LEON W.....Lebanon, Ind.
CLEVENGER, W. L.....Dairy Department, State College, Raleigh, N. C.
CLUTTER, J. G.....College Station, Tex.
COHEE, C. I.....1211 Arch Street, Philadelphia, Pa.
COLMAN, H. N.....Dairy Department, Corvallis, Ore.
COMBS, W. B.....Dairy Division, University Farm, St. Paul, Minn.
COOK, ALFRED.....Plainsboro, N. J.
COOLEDGE, L. H. (deceased).....East Lansing, Mich.
CORBETT, L. S.....Orono, Me.
CUNNINGHAM, O. C.....New Mexico College of Agriculture, Dairy Department, State College, N. M.
CAMBURN, O. M.....4-A Oak Knoll, Arlington, Mass.
CUNNINGHAM, WALTER S.....University of Arizona, Tucson, Ariz.
CUMMINGS, CHARLES M.....Peterboro, N. H.
CLARK, R. S.....Huntingdon County Farm Bureau, Huntingdon, Pa.

DAHLBERG, A. C.....Experiment Station, Geneva, N. Y.
DAHLBERG, A. O.....175 Franklin Street, New York, N. Y.

DAHLE, CHESTER D.....Dairy Department, State College, Pa.
DARGER, H. C.....Blue Valley Creamery Company, Chicago, Ill.
DAVIS, H. P.....Dairy Department, Lincoln, Nebr.
DARNELL, A. L.....College Station, Tex.
DE PEW, H. F.....State College, Durham, N. H.
DICE, J. R.....Agricultural College, Fargo, N. D.
DOAN, F. J.....Dairy Department, College Park, Md.
DUNNE, J. E.....Hazelwood Ice Cream Company, East 6th and Main Streets, Portland, Ore.
DVORACHEK, H. E.....Fayetteville, Ark.
DRAIN, HARRY D.....Ohio State University, Columbus, Ohio.

ECKLES, C. H.....University Farm, St. Paul, Minn.
ELLENBERGER, H. B.....University of Vermont, Burlington, Vt.
ELLINGTON, E. V.....Dairy Department, Pullman, Wash.
EPPLE, W. F.....311 Sylvia Street, W. Lafayette, Ind.

FAY, A. C.....Department of Bacteriology, K. S. A. C. Manhattan, Kans.
FISHER, R. C.....Storrs, Conn.
FITCH, J. B.....Dairy Department, Manhattan, Kans.
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FRANDSEN, J. H.....1401 N. 33rd Street, Lincoln, Nebr.
FRASER, W. J.....Urabana, Ill.
FULLER, J. M.....New Hampshire College, Durham, N. H.
FITTS, E. B.....Department of Agricultural Extension, State College, Pa.
FREVERT, G. E.....Newman, Calif.
FOLGER, ARTHUR.....Davis, Calif.
FORBES, E. B.....Institute of Nutrition, State College, Pa.
FOURT, D. L.....University Extension Division, Boise, Idaho.

GANNON, E. A.....Purdue University, Lafayette, Ind.
GAMBLE, J. A.....University of Maryland, College Park, Md.
GARDNER, M. H.....Delavan, Wis.
GEARHART, C. R.....Dairy Department, State College, Pa.
GIFFORD, WARREN.....Dairy Department, Morgantown, W. Va.
GOSS, C. A.....The Dairy Farmer, Des Moines, Iowa.
GOSS, E. F.....Iowa State College, Ames, Iowa.
GREGORY, H. W.....416 Harvey Avenue, Lafayette, Ind.
GREEN, SAM H.....216 Pine Street, in care of California Dairy Council, San Francisco, Calif.
GREY, C. E.....California Central Creamery Company, 417 Market Street, San Francisco, Calif.
GULLICKSON, T. W.....University Farm, St. Paul, Minn.
GUTHRIE, E. S.....Cornell University, Ithaca, N. Y.

GOODWIN, O. T.....Michigan Producers Dairy Company, Adrian, Mich.

HALE, JOSEPH C.....Akron Pure Milk Company, Akron, Ohio.
HAMMER, B. W.....Iowa State College, Ames, Iowa.
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HARMON, E. M.....Dairy Department, Columbia, Mo.
HARRISON, HARTMAN K.....Linden Avenue and Dolphin Street, Baltimore, Md.
HANSEN, A. P.....Director State Extension Creamery, Copenhagen, Denmark.
HARRIS, ROY T.....Madison, Wis.
HAYDEN, C. C.....Experiment Station, Wooster, Ohio.
HASTINGS, E. G.....University of Wisconsin, Madison, Wis.
HASLERUD, E. J.....Dairy Department, Bozeman, Mont.
HARVEY, SAMUEL H.....College Park, Md.
HEINEMAN, H. E. O.....327 S. LaSalle Street, Chicago, Ill.
HENING, J. C.....New York Experiment Station, Geneva, N. Y.
HERZER, F. H.....Agricultural College, Miss.
HINDLEY, R. W.....1406 Carlisle Avenue, Racine, Wis.
HISCOCK, IRA V.....62 Park Street, New Haven, Conn.
HOOPER, J. J.....Kentucky Agricultural College, Lexington, Ky.
HOOPER, H. A.....Cornell University, Ithaca, N. Y.
HOOVER, JESSIE M.....Dairy Bureau, Washington, D. C.
HOWELL, A. J.....619 E. Fourth, Ottawa, Kan.
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HUFFMAN, CARL F.....Michigan Agricultural College, Dairy Department, E. Lansing, Mich.
HUGGLER, N. A.....In care of Carl Gluns, Clinton Street, Galeton, Pa.
HUNZIKER, O. F.....Blue Valley Creamery Company, Chicago, Ill.
HUTTON, C. A.....Extension Division, Knoxville, Tenn.
HOLDAWAY, C. W.....Blacksburg, Va.
HIGGINS, L. A.....Starkville, Miss.
HAZLEWOOD, BEN P.....1218 W. Clinch Avenue, Knoxville, Tenn.

INGHAM, LEROY W.....College Park, Md.

JACKSON, H. C.....610 Superior Street, Grove City, Pa.
JAMISON, NEAL C.....Extension Division, Corvallis Ore.
JONES, H. M.....Dairy Specialist, Brookings, S. D.

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JOHNSON, ROBERT E.....Storrs, Conn.
JUDKINS, H. F.....Dairy Department, Amherst, Mass.

KEENEY, M. H.....Cedar Grove, N. J.
KELLEY, FRANK W.....Gridley Dairy Company, Milwaukee, Wis.
KILDEE, H. H.....Ames, Iowa.
KNAPP, I. R.....60 West Main Street, Somerset, Pa.
KNOX, FREDRICK H.....Portland, Mich.
KOCH, ARTHUR.....Minerva, Ohio.
KOCH, IRVING O.....Moore-Ross Milk Company, Columbus, Ohio.

LADD, JOHN E.....Animal Husbandry Department, Rhode Island State College, Kingston, R. I.
LAMASTER, J. P.....Dairy Division, Clemson College, S. C.
LARSON, C.....State College, Brookings, S. D.
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LEHMKUHL, HENRY.....84 Exchange Street, Rochester, N. Y.
LIDE, B. M., JR.....2008 Pine Street, St. Louis, Mo.
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LUSH, R. H.....Dairy Department, Manhattan, Kan.

MACY, HAROLD.....University Farm, St. Paul, Minn.
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MASON, R. H.....Dairy Department, Fayetteville, Ark.
MASUROVSKY, BENJAMIN.....Dairy Department, Lincoln, Nebr.
MEAD, S. W.....Davis, Calif.
MEIGS, E. B.....1445 Rhode Island Avenue, Washington, D. C.
MEISTER, ALBERT.....Capitol Dairy, 315 Sixteenth Street, Sacramento, Calif.
MERRILL, A. R.....Storrs, Conn.
MONRAD, K. J.....Chris Hansen Laboratories, Little Falls, N. Y.

MOORE, J. S.....Agricultural College, Miss.
MOSELEY, THOMAS W.....Huntley Experiment Farm, Huntley, Mont.
MORRIS, ARTHUR J.....Cedar City, Utah.
MORTON, GEORGE E.....Fort Collins, Colo.
MORTENSEN, M.....Iowa State College, Ames, Iowa.
MILLER, MILTON M.....442 East 58th Street, Portland, Ore.
MUDGE, COURTLAND S.....Davis, Calif.
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MUSSER, KARL B.....Peterboro, N. H.
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MIYAWAKI, ATSUSHI.....Professor of Dairying, Imperial University, Sappora, Japan.

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MCCANDLISH, A. C.....Claunch, Sorbie, Wigtownshire, Scotland.
MCINERNEY, THOMAS J.....Dairy Department, Cornell University, Ithaca, N. Y.
MCWHORTER, G. E.....Milledgeville, Ga.
MORRISON, F. B.....University of Wisconsin, Madison, Wis.
MCDOWELL, J. C.....Dairy Bureau, Washington, D. C.

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NELSON, J. A.....Montana State College, Bozeman, Mont.
NEVENS, W. B.....College of Agriculture, Urbana, Ill.
NEWLANDER, J. A.....101 Brooks Avenue, Burlington, Vt.
NORTH, DR. C. E.....30 Church Street, New York, N. Y.
NORTON, H. W.....Lansing, Mich.
NYSTROM, A. B.....1819 G Street, N.W., Washington, D. C.

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OLSON, T. M.....Dairy Department, Brookings, S. D.

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PARKER, JOSEPH B.....Dairy Bureau, Washington, D. C.
PACE, D. J.....Maple Falls, Wash.
PARFITT, E. H.....Purdue University, W. Lafayette, Ind.
PERRY, E. J.....New Brunswick, N. J.
PETERSEN, W. E.....Dairy Department, University Farm, St. Paul, Minn.
PEARSON, R. A.....Ames, Iowa.

POMEROY, CARL T.....Health Officer, Montclair, N. J.
POTTS, ROY C.....Department of Agriculture, Washington, D. C.

QUIGLEY, J. V.....Consumers' League, 408 East 11th Street, Kansas City, Mo.

RISHOI, A. H.....Dairy Department, Washington State College, Pullman, Wash.
RAGSDALE, A. C.....University of Missouri, Columbia, Mo.
REED, O. E.....Dairy Department, E. Lansing, Mich.
REGAN, M. J.....Dairy Department, Columbia, Mo.
REGAN, W. M.....Agricultural Experiment Station, Davis, Calif.
RENNER, K. M.....Dairy Department, Manhattan, Kans.
ROADHOUSE, C. L.....University of California, Davis, Calif.
ROBBERS, WALTER.....Dairy Department, New Jersey Agricultural Station, New Brunswick, N. J.
ROGERS, L. A.....Dairy Bureau, Washington, D. C.
ROSS, H. E.....Cornell University, Ithaca, N. Y.
RUEHE, H. A.....Dairy Department, Urbana, Ill.
RUFFNER, R. H.....State College, Raleigh, N. C.

SHERIDAN, MARTIN J., JR.....Blossom Hill Farms, Lebanon, N. J.
SAMMIS, J. L.....Madison, Wis.
SCOTT, GEORGE W.....Dairy Department, University of Alberta, Edmonton, Alberta, Canada.
SHEPHERD, J. B.....Bureau of Animal Industry, Ardmore, S. D.
SHERMAN, J. M.....Dairy Industry Building, Ithaca, N. Y.
SIDELMANN, I. O.....State College, Pa.
SLATER, EDWARD K.....5th and Cherry Streets, Milwaukee, Wis.
SCHAEFER, O. G.....University Farm, St. Paul, Minn.
SMITH, R. W., JR.....Dairy Department, Massachusetts Agricultural College, Amherst, Mass.
STOCKING, W. A., JR.....Dairy Department, Cornell University, Ithaca, N. Y.
STOLTZ, R. B.....Dairy Department, Columbus, Ohio.
SUPPLEE, GEORGE C.....Dry Milk Company Research Laboratory, Brainbridge, N. Y.
STUART, DUNCAN.....Bureau of Dairying, Washington, D. C.
SHUTT, D. B.....Division of Veterinary Science, Michigan Agricultural College, E. Lansing, Mich.
SOMMER, H. H.....Dairy Department, Wisconsin University, Madison, Wis.
SUTERMEISTER, L. A.....Dayton, Ohio.
SWETT, W. W.....Bureau of Dairying, Washington, D. C.

THOM, CHARLES.....Bureau of Chemistry, Department of Agriculture, Washington, D. C.

THURSTON, L. M.....Dairy Department, University Farm, St. Paul, Minn.
TAYLOR, C. L.....1200 S. Clay Street, Louisville, Ky.
TROY, H. C.....Cornell University, Ithaca, N. Y.
TURNER, CHARLES W.....Dairy Department, Columbia, Mo.
TOBIAS, JAMES HENRY.....136 State Street, W. Lafayette, Ind.

URNER, F. G.....Urner-Barry Company, 173 Chambers Street, New York, N. Y.

VAN NORMAN, H. E.....National Dairy Association, 910 S. Michigan Avenue, Chicago, Ill.
VAN LANGE, OSCAR.....P. O. Box 3134, San Francisco, Calif.
VAN SLYKE, L. L.....Geneva, N. Y.

WING, R. E.....Dairy Department, Connecticut Agricultural College, Storrs, Conn.
WALTS, CHARLES C.....Dairy Department, Storrs, Conn.
WASHBURN, R. M.....2239 Goodon Avenue, St. Paul, Minn.
WEAVER, EARL.....Ames, Iowa
WELD, IVAN C.....Chestnut Farms Dairy, Washington, D. C.
WHITE, G. C.....Storrs, Conn.
WHITE, WILLIAM.....Dairy Division, Washington, D. C.
WILBUR, J. W.....Smith Hall, Purdue University, Lafayette, Ind.
WILLIAMS, G. A.....Purdue University, W. Lafayette, Ind.
WILLIAMS, V. M.....Animal Industry Division, State College Station, Raleigh, N. C.
WING, H. H.....Cornell University, Ithaca, N. Y.
WINKJER, JOEL G.....Dairy Division, Washingtn, D. C.
WYLIE, C. ELMER.....Morrill Hall, University of Tennessee, Knoxville, Tenn.
WILLIAMS, P. S.....Dairy Department, State College, Pa.

ZEIGLER, P. R.....Wright-Zeigler Company, Boston, Mass.

CONSTITUTION AND BY-LAWS OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

(As revised 1925)

CONSTITUTION

NAME

Article 1. The name of the organization shall be the American Dairy Science Association.

OBJECT

Article 2. The object of the Association shall be to advance the general welfare of the dairy industry, especially by the improvement of dairy instruction, by the stimulation of scientific research in all phases of the subject and by improvement in methods of conducting extension work.

MEMBERSHIP

Article 3. Membership shall consist of two kinds (1) active, (2) associate.

Article 4. The qualifications for membership in the two classes are as follows: (*a*) Any person is eligible to active membership who is formally announced by an Agricultural College, or Experiment Station, or by the Bureau of Dairying of the United States Department of Agriculture as an instructor, extension worker, investigator, or administrative officer connected with the dairy industry, or (*b*) anyone filling a position of responsibility connected with the dairy industry and who has had a college or university training in technical science, or anyone filling a responsible position in the industry of a professional character requiring a technical knowledge of dairying of a high order.

Any person is eligible to associate membership who is regularly enrolled in a collegiate course in a college of agriculture and who is specializing in dairying.

Article 5. Nominations for active membership shall be submitted to the Executive Committee in written form and signed by at least three members. Upon receiving the unanimous endorsement of the Executive Committee and paying the annual membership dues, the candidate shall be duly enrolled as a member of the Association.

Article 5-a. Associate membership is attained by election to membership in a local chapter of the American Dairy Science Association. Election may be by such means as are prescribed by the local chapter subject only to the qualification for associate membership as specified in Article 4, and the approval of the head of the Department of Dairying or Dairy Husbandry in the institution where the chapter is located. Associate membership expires two years after the holder ceases to be enrolled as a student.

OFFICERS

Article 6. The officers of this Association shall be President and Vice-President, whose term of office shall be one year; a Secretary-Treasurer and a Journal Editor, whose term of office shall be two years. The term of office shall begin January first.

The President, the Vice-president and the Secretary-Treasurer and the presiding officers of the divisions of the Association shall constitute the Executive Committee.

Article 6-a. A representative of this Association to the National Research Council shall be elected for a term of three years. He shall be ineligible for re-election, shall be chosen from the members of the National Research Council Advisory Committee and shall be chairman ex-officio of the Committee. The term of office shall begin July first following his election.

DUTIES OF OFFICERS AND MANNER OF ELECTION

Article 7. The duties of the officers shall be those usually pertaining to their respective offices. The Executive Committee shall pass upon all nominations for membership, all applications for divisions, sections, and chapters of the Association. It shall have the power to fix the time and place for the annual meeting and shall be authorized to transact such business of the Association as demands attention while the Association is not in session.

Article 8. On or before November first, the Secretary shall mail to each active member a blank on which he shall be entitled to express his choice for each office to be filled. This blank shall give the names of those serving in the offices to be filled for five years preceding and a report of the Committee on Elections which shall suggest the names of two members for each office to be filled. All ballots shall be counted by the Secretary and later verified by the President. In case no candidate has a majority by the first ballot, a second ballot shall be sent to the members, giving the names of the three leading candidates for each office and the number of votes received. The candidates receiving the most votes on the second ballot shall be declared elected. In case of tie on the second ballot, the decision shall be made by the Executive Committee.

ORGANIZATION OF DIVISIONS AND SECTIONS

Article 9. Professional groups based on geographical considerations to be known as divisions of the Association and to be organized by active members of the Association may be authorized by the Executive Committee when such action shall seem expedient. The officers of the division shall be a chairman and such other officers as are provided by the division. The presiding officers of the divisions shall be ex-officio vice-presidents of the Association.

The divisions shall have the right to make by-laws for their own government which shall not be inconsistent with the constitution and by-laws of the Association.

Membership in division of the Association is open only to those regularly elected active members of the Association.

Any division may raise or collect funds to be expended for its own purpose.

Article 10. Professional groups based upon specialized interests to be known as sections of the Association and to be formed by not less than 10 active members

may be authorized by the Executive Committee when considered for the best interests of the Association.

Such sections may elect their own officers and may make any rules for their own guidance not inconsistent with the constitution and by-laws of the Association.

Article 10-a. Local groups known as chapters may be authorized by the Executive Committee on petition from a group of members of the Association or of students qualified for associate membership according to Article 4. The officers of the chapter shall be a chairman and such other officers as the chapter shall provide. Membership is limited to those elected under conditions as given in Article 4. Each chapter may make rules for its guidance, not inconsistent with the constitution and by-laws of the American Dairy Science Association and may raise or collect funds to be expended for its own purposes.

AMENDMENTS

Article 11. The constitution may be amended by a two-thirds vote at any regular meeting of the Association: provided the proposed amendments have been submitted to the Executive Committee in writing not less than thirty days previous to the meeting at which the vote is taken; and provided the proposed amendment is approved by a majority of the Executive Committee.

Article 12. The Executive Committee may at its discretion submit proposed amendments which have received the approval of the committee to the active members of the Association for vote by mail. An affirmative vote of two-thirds of all voting and which shall be not less than a majority of the active membership shall be necessary for approval.

By-Laws

Article 1. The active membership dues shall be $5.00 a year, payable January first, each year.

Article 1-a. Annual dues for associate membership shall be fifty cents and shall be collected for the members of a chapter by such officer as the chapter may designate for the purpose and forwarded to the Secretary-Treasurer of the American Dairy Science Association.

Article 1-b. Associate members shall have the privilege of subscribing to the Journal of Dairy Science at a rate of $2.50 a year, the subscription to begin with the calendar year and to continue twelve (12) months.

Article 2. The Journal of Dairy Science shall not be sent to any member whose dues are not paid by April 11th of the year for which the membership is held.

Article 3. Any members in arrears for dues for more than one year shall thereby cancel membership but may be restored to membership without any action by the Association by payment of all arrears including dues for the current year.

Article 4. The time and place of the meetings of the Association shall be fixed by the Executive Committee.

Article 5. A quorum at any meeting for the transaction of business shall consist of not less than ten per cent of the active members.

Article 6. A committee of five on elections shall be appointed by the President. Said committee shall make a report at the annual meeting in which the names of

two members shall be suggested for each office to be filled by mail ballot under the provision of the constitution. In addition thereto, a group of five or more active members may suggest other names for consideration but such requests shall be in the hands of the Secretary of the Association before November first.

Article 7. In conducting mail ballots only those ballots shall be counted which are received by the Secretary within four weeks from the date upon which ballots were mailed by the Secretary.

Article 8. Section Meetings. The time and place of meeting for the Sections of the Association shall be fixed by the Executive Committee. All other arrangements regarding the section meetings shall be made by the officers of the section.

Article 9. These by-laws may be amended at any regularly called meeting by a two-thirds vote of those present.

Article 10. The National Research Council Advisory Committee of this Association shall consist of six members in addition to the official representative of the Association. It is to be the function of this Committee to advise with the Association's representative to the National Research Council in the performance of his official duties. The members of the Committee shall be appointed by the President of the Association and shall serve for three years. The initial appointments shall be for such time as shall cause the terms of office of two members of the Committee to expire each year. The term of office shall begin July first.

DAIRY NOTES

PENNSYLVANIA

L. W. Morley, dairy extension specialist of the Pennsylvania State College has been selected by the American Jersey Cattle Club to head their extension and development division including Register of Merit work. Professor Morley is also chairman of the Extension Section of the American Dairy Science Association.

KANSAS

N. E. Olson, associate professor of dairy husbandry in charge of dairy manufactures in the college and station resigned his position June 1st to go into commercial work at Wichita.

MICHIGAN

L. H. Cooledge, research associate in bacteriology since 1912, died May 12, at the age of thirty-seven years. He was a native of South Dakota, graduating from the South Dakota College in 1911 and receiving the M.A. degree from the University of Missouri in 1912. Among his contributions to science was the development of the colorimetric hydrogen-ion method of determining the keeping qualities of dairy products. He was also among the first to study the occurrence of *Bacterium abortum* in the milk of the cow, and he has made numerous contributions on that subject.

AMERICAN DRY MILK INSTITUTE

Dr. H. E. Van Norman has recently been elected president of the American Dry Milk Institute with headquarters at 160 North La Salle Street, Chicago. Dr. Van Norman has direct charge of the research and educational work of that association.

BUREAU OF DAIRYING

J. H. McClain formerly in charge of the Bureau's extension work in the South has just been made head of the introduction section of the Bureau of Dairying. Mr. McClain fills the vacancy caused by the death a few weeks ago of Mr. S. C. Thompson who had been connected with the Bureau for a number of years.

WESTERN DIVISION OF AMERICAN DAIRY SCIENCE ASSOCIATION, ANNUAL MEETING, MULTNOMAH HOTEL, PORTLAND, ORE., NOVEMBER 1 AND 2, 1925

Tentative program

November 1, 9:30 a.m.—General Assembly.

Business Meeting.

Reports of Committees.

November 1, 1:30 p.m.—Sectional Meetings.

Production Section: Chairman, H. M. King, University of British Columbia, Secretary, E. E. Anderson, Oregon Agriculture College.

Program: Speaker

Discussion: Revision of Dairy Cattle Judging Contest Rules for 1926, J. E. Dorman, U. S. B. D. Salt Lake City, Chairman.

Manufacturing Section: Chairman, G. D. Turnbow, University of California; Secretary, N. S. Golding, University of British Columbia.

Program: Paper: "Developing Types of Cheese and Possibilities in the Cheese Industry," N. S. Golding.

Discussion: Revision of Dairy Products Judging Contest Rules for 1926, H. R. Lochry, U. S. B. D., Salt Lake City, Chairman.

Discussion on Prizes.

Trial Judging of Ice Cream by Dairy Products Judging Coaches, G. D. Turnbow, University of California, in charge.

November 2, 9:30 a.m.—General Assembly.

Address: "The Utilization of By-Products and its Influence on the Industry," Dr. L. A. Rogers, in charge Research Laboratories, Bureau of Dairying, Washington, D. C.

Report of Committee on Standardization of Experimental Methods and Program of Problems, E. V. Ellington, Washington State College, Chairman.

Suggestions from Dr. L. A. Rogers, U. S. Bureau of Dairying.

Adjournment.

[President H. A. Bendixen, of the Western Division of the American Dairy Science Association, in sending this tentative program, says all indications are for a splendid meeting this year. All dairy workers particularly interested in western dairying should arrange to attend. Remember the dates November 1 and 2, and the place Portland Oregon.—*Editor*.]

Twentieth Annual Convention

AMERICAN DAIRY SCIENCE ASSOCIATION

INDIANAPOLIS, INDIANA
OCTOBER 12 and 13

Hotel Severin will be headquarters for the A. D. S. A. Write for reservation mentioning the fact that you are a member of the association.

The meetings of the Association will be held at the Hotel Severin beginning at 9:00 a.m. Monday, October 12. Dean Alfred Vivian of Ohio State University will address the morning session. Many other prominent speakers will appear on the program.

The banquet will be held on Tuesday evening, October 13, at 6:30 p.m. A. J. Glover, editor of Hoards Dairyman, will be the principal speaker at the banquet. Results of the Students Judging Contest will be announced at this time. A program of interest to all members is promised.

(Over)

SECTION II—MANUFACTURING

Monday, October 12, 1925, 2 P.M.

CALL TO ORDER BY CHAIRMAN,
H. F. Judkins, Amherst, Mass.

READING OF MINUTES, SECRETARY,
N. E. Olsen, Wichita, Kansas

REPORTS OF STANDING COMMITTEES,

CARDS FOR THE NATIONAL CONTEST IN JUDGING DAIRY PRODUCTS,
H. F. Judkins, Amherst, Mass.

BACTERIOLOGICAL METHODS: A. MILK, B. ICE CREAM,
R. S. Breed, Geneva, New York

SCORE CARDS AND LEGAL STANDARDS,
J. H. Frandsen, Lincoln, Nebraska

ECONOMIC PHASES OF DAIRY MANUFACTURING,
R. C. Potts, Bur. Agric. Economics, Washington, D. C.

METHODS OF DETERMINING MILK SOLIDS IN FATS,
O. R. Overman, Urbana, Illinois

REPORTS OF SPECIAL COMMITTEES,

TESTING ICE CREAM FOR FAT AND SOLIDS,
R. C. Fisher, Cincinnati, Ohio

THE OPERATION OF COLLEGE CREAMERIES,
P. M. Brandt, Corvallis, Oregon

SERIES OF 15 MINUTE TALKS,

CAN A CITY MILK ORDINANCE BE ENFORCED?
J. D. Brew, Ithaca, New York

FEDERAL STATE BUTTER INSPECTION SERVICE AS A MEANS FOR QUALITY IMPROVEMENT,
C. W. Fryhofer, St. Paul, Minn.

CORRELATION OF THE SCORED BUTTER AND ITS METHOD OF MANUFACTURE WITH THE INFLUENCE OF YEASTS AND MOLDS,
E. H. Parfitt, Urbana, Illinois

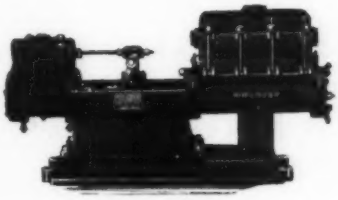
JUDGING DAIRY PRODUCTS IN OUR HIGH SCHOOLS,
C. L. Roadhouse, Davis, California

RELATIONS BETWEEN THE COLLEGE DAIRY MANUFACTURES RESEARCH WORKER AND COMMERCIAL DAIRY INTERESTS,
O. F. Hunziker, Chicago, Illinois

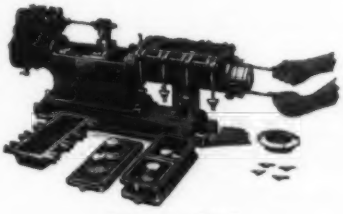
THE EFFECT OF ICE CREAM INGREDIENTS UPON THE VISCOSITY OF THE MIX,
P. A. Downs, Lincoln, Nebraska

BUFFLOVAK

Sanitary Milk Pumps



Assembled



Disassembled

A pump that overcomes the difficulties peculiar to pumping milk product

THE BUFFLOVAK Sanitary Milk Pump overcomes the difficulties peculiar to pumping milk products. All parts in the liquor end of the pump including the cylinder, piston and valve mechanism, are made entirely of bronze, so that the most exacting sanitary requirements of the dairy industry are completely fulfilled.

The utmost accessibility is afforded by its simplicity of construction. By loosening eight nuts, the entire valve mechanism may be completely disassembled for cleaning.

The piston may be withdrawn after removing four wing nuts which hold the cylinder head in place.

BUFFALO FOUNDRY & MACHINE CO.

1581 Fillmore Ave., Buffalo, N. Y.

NEW YORK **CHICAGO**

Your advertisement is being read in every State and in 25 Foreign Countries

DAIRY PROFITS

The highest quality cream from the best dairy herds should make the finest dairy products and realize the greatest profits.

Failure to realize these profits oftentimes results because the finer the quality of the cream the more susceptible of contamination and spoilage from the unsuspected causes which lodge in improperly cleaned cans, containers and dairy equipment.

The removal of these harmful and objectionable factors is being easily and quickly accomplished in thousands of Creameries, Dairies and Cheese Factories by the use of

Wyandotte
Dairyman's
Cleaner and Cleanser

This cleaner is a mild alkali product with a natural cleaning action. Every particle is an active working particle dependable to the last grain. Its day to day performance is your guarantee of faultless dairy sanitation at a low cleaning cost.

Indian in circle

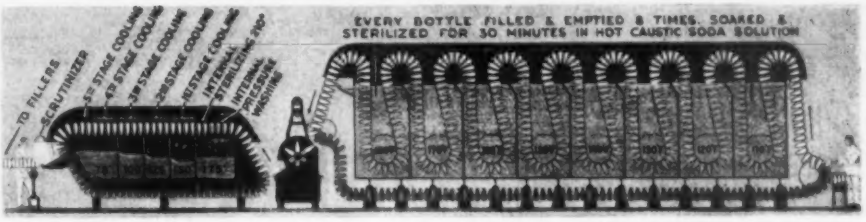
in every package.

Order From Your Supply House

It Cleans Clean

The J. B. Ford Company, Sole Mnfrs. Wyandotte, Mich.

Your advertisement is being read in every State and in 25 Foreign Countries


TO FILLERS
SCRUTINIZER
1ST STAGE COOLING
2ND STAGE COOLING
3RD STAGE COOLING
4TH STAGE COOLING
INTERNAL STERILIZING
INTERNAL PRESSURE WASHING
EVERY BOTTLE FILLED & EMPTIED 8 TIMES. SOAKED & STERILIZED FOR 30 MINUTES IN HOT CAUSTIC SODA SOLUTION

Economy in Bottle Handling

THIS Giant Barry-Wehmiller unit delivers 180 clean, bacteriologically sterile bottles a minute. Every bottle is soaked for 30 minutes in caustic soda solution, washed by hot water at high pressure, sterilized at 210°, and cooled *without reinfection.* The B-W Soaker-Washer-Sterilizer is designed for economy as well as efficiency. Automatic transference of bottles, combining these processes in one continuous operation makes possible great economy in handling charges. Graduated temperatures prevent breakage of bottles; machinery is carefully designed to avoid wear and tear—repair bills are almost nil.

Exclusive Features

a. Complete mechanical separation of the soaking process, involving the use of caustic soda, from the washing, sterilizing and cooling processes.

b. Construction of soaker pockets, entirely free from lodging places for dirt, to allow easy access for cleaning.

c. Continuous motion in the soaker avoiding wear and tear on the heavier machinery.

d. Complete drainage of bottles as they emerge from soaker.

e. Automatic transference of bottles from one machine to the other.

f. Washing by hot water at high pressure from spindles entirely within the bottle and in close contact with the glass. (No unsanitary brushes.)

g. Complete separation of the carrying chain from interior of the washer and sterilizer, saving wear and tear on the chain and preventing reinfection of the bottles.

h. Step by step motion on the washer to insure thorough cleaning.

i. Cooling by application of water to the exterior only of the bottle.

Six of these B-W units are used in the largest plants of the Sheffield Farms Company, New York City. Adopted by one of the largest European Dairies.

Barry-Wehmiller approved "In the bottle" pasteurizers, used in combination with the Soaker-Washer-Sterilizer forms a most practical bottling system. At the Deerfoot Farms Dairy, Southborough, Mass., and the New Haven Dairy Company, New Haven, Conn., and A. Stapleton and Sons, Brooklands Farm, London, England, this system has proven very successful.

Many types and capacities, "Midget" to "Giant" size. Information gladly given.

Barry-Wehmiller Machinery Co.

4672 West Florissant Avenue
ST. LOUIS, MO. U. S. A.

Announcing A NEW SERIES OF LOW PRICED GLASS LINED EQUIPMENT

Model "C"—60 Gallon Pasteurizer, Starter Tank, Etc.

Model "B"—Water-ice and Sherbert Mixer.

[See the Pfaudler Exhibits at the Dairy Exposition in Indianapolis, October 10 - 17]

WE are now offering to the dairy and ice cream industries a new series of small-unit glass lined tanks which are priced so low as to be of interest to every manufacturer in the field.

There is a 60 gallon pasteurizer, built exactly like the "C-Gal" (100 gal.) and referred to as our **Model "C" Pasteurizer.** It may be used for pasteurization, starter purposes, the manufacture of ice cream mix, etc., and sells for $260.00 f. o. b. factory. The "C-Gal" (100 gal.) sells for $325.00 f. o. b. factory.

The Portable Tank, Model "D," is being adopted by leading ice cream manufacturers and has many advantages. This tank is suitable for transporting fruits and syrups from storage to the freezers. It eliminates waste and speeds up production. The tank is made in three sizes, 30, 60 and 100 gallons, and sells respectively for $72.50, $87.50 and $112.50.

The Model "B" Water-ice Mixer is made in two sizes, 60 and 100 gallons, and is especially adapted for making cold batches of ices, sherberts, etc. This unit sells in the 60 gallon size at $98.00, and in the 100 gallon size at $125.00.

The Model "Y" Mixing or Storage Tank is a single shell, closed, storage tank equipped with agitator and suitable for temporary storage as a balance between two other units, such as, receiving tank and pasteurizer. Made in two sizes, 60 and 100 gallons; prices, $135.00 and $167.00.

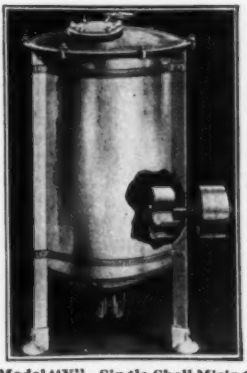
All Prices F. O. B. Elyria, Ohio

NOTE: Models "B" and "D" illustrated herewith may be equipped with 1-Piece Copper-Tinned Cover. Prices as follows: 30 gal. size, $9.00; 60 gal. size, $12.00; 100 gal. size, $16.00.

Order by Mail Now!

Our specially-equipped Mail-Order Department renders immediate service on all business placed direct through the mails. We have an unusual volume of small tank orders which are being handled in this manner. Prices listed are based on present cost of material and labor. They are subject to change without notice. Take advantage of them NOW.

Model "D" Portable Tank, for Fruit and Syrups



Model "Y"—Single Shell Mixing and Storage Tank

[See the Pfaudler Exhibits at the Ice Cream Show Detroit, October 19 - 24]

Pfaudler

MAIL THIS COUPON

THE PFAUDLER CO.,
217 Cutler Bldg., Rochester, N. Y.

Gentlemen:—Please enter our order for:.....

.....

(Be sure to include cover, if you want it.)

☐ Merely send literature.

NAME..... STREET..... CITY.....

J. D. S. 9-25

Your advertisement is being read in every State and in 25 Foreign Countries

The colored streaks of weakness now eliminated in *The* KIMBLE *New Process* BOTTLE

ABOVE are actual reproductions from polariscope (an instrument for detecting strains in glass) color photographs. These photographs were neither retouched nor altered in any way,—thus they tell an authentic story.

In the manufacture of a milk or cream test bottle, strains are introduced in various places, due to the heating and cooling which the bottles pass through. These strains are invisible to the naked eye, but they are points of vital weakness.

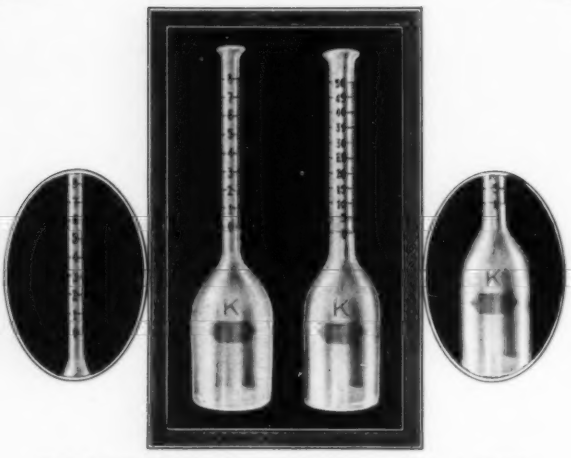
In our new process bottle, we remove these strains, giving you a bottle free from this invisible, but serious defect.

The bottle on the left was not processed,—the colored streaks or weaknesses, are the places where breakage usually occurs. The bottle on the right was processed, and it is apparent, because of the absence of colored streaks, that the weaknesses have been absolutely eliminated.

Kimble has positively corrected these invisible weaknesses in Test Bottles.

This new process is an exclusive Kimble Development.

The Visible Guarantee of Invisible Quality



KIMBLE *New, Shiny* BLACK

Numerals and Graduations

IMPERVIOUS to Acid and Washing Solutions

IT has always been impossible to obtain Test Bottles, on which the colored numerals and graduations would remain after many washings. This constant source of dissatisfaction has been absolutely eliminated by the New, Shiny Black Impervious Kimble Filling.

Kimble Test Bottles can now be washed time and time again, without affecting their readability.

This new development of the Kimble Research Laboratory is far superior to the old types of common pigment enamels and carbon base fillers, heretofore used. The Kimble Shiny Black sticks so tenaciously, that it is practically a part of the bottle.

Another new feature of the Test Bottle, is the double line numeral. This great improvement over the single line numeral will be appreciated by the operator.

Instead of the customary acid etched writing spot, the Kimble Spot is sand blasted, giving the glass a writing paper finish. The marks you put on the spot stay there, until you erase them.

Every operation in the manufacture of Kimble Bottles, from molten glass to finished bottle, is done in our own plant.

We will be glad to send you a free sample, of one of the new Kimble Bottles.

Write us on your letterhead, giving us the name of your jobber. No obligations.

The Visible Guarantee of Invisible Quality

KIMBLE GLASS COMPANY

New York VINELAND N.J. Chicago

BOOTH 56 DAIRY SHOW

The Mojonnier Tester

for rapid and accurate butter fat and total solids tests

MOJONNIER MILK TESTER, MODEL D

Process patented April 3, 1917. Apparatus patented February 5, 1918; June 11, 1918; August 5, 1919; March 1st, 1920; March 16, 1920; April 6, 1920; March 21, 1921; September 27, 1921; February 27, 1923

It pays to test your raw materials and finished products accurately.

Every year has seen more Mojonnier Testers being used in the dairy plants of this and foreign countries and the rapidity with which the value of this equipment was appreciated is illustrated graphically below.

MOJONNNIER TESTERS IN USE

The sole reason for this increase has been the fact that the Mojonnier Tester offered the only rapid and accurate method for testing any dairy product for butterfat and total solids enabling the practical immediate use of the results obtained by standardizing the product during processing and production—an economical advantage which invariably paid for the equipment the first year of its operation.

There is a Mojonnier Tester to meet the requirements of any size plant from the plant producing a million gallons of product a year to the plant producing ten thousand gallons a year. The advantages of accurate standardization are the same in any case—a continual saving in dollars and cents and an absolutely uniform product, whether ice cream, evaporated milk, or table cream.

SALES BRANCHES

MT. VERNON, NEW YORK
ST. LOUIS, MO.
COLUMBUS, OHIO

Mojonnier Bros. Co.

4601 W. Ohio St. Chicago, Ill.

See our Exhibit at the National Dairy Show, Indianapolis

Your advertisement is being read in every State and in 25 Foreign Countries

ENGRAVINGS FOR MEDICAL AND SCIENTIFIC PUBLICATIONS

MANY years experience working in co-operation with publishers and authors, engaged in the scientific field, have admirably fitted us for this exacting work. Our clientele includes, among many others, the scientists of the Johns Hopkins University. Such widely diversified subjects as Biology, Mineralogy, Physics, Medicine, Surgery, Zoölogy, Mathematics, etc., etc., are constantly requiring our services, in the matter of engraving reproductions.

Naturally, we have developed an intimate knowledge of the requirements of this particular phase of the photo-engraving industry. We understand the particular illustrative points that must be emphasized. We are accustomed to working, moreover, from written instructions, since our clients are frequently out of direct touch with us, or at distant points.

That we have been eminently successful is attested by even our most critical patrons, whom we continue to serve after many years of patronage.

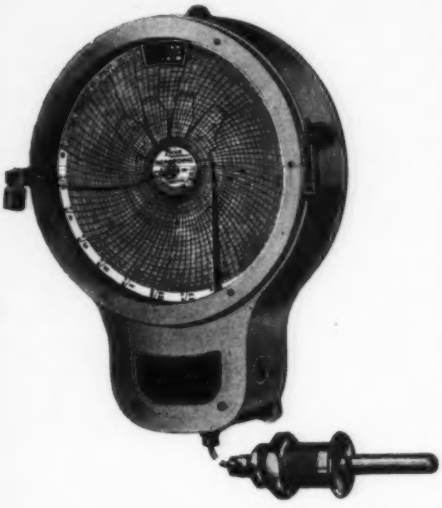
We will be glad to submit samples, make estimates and co-operate, in every possible way, in the production of YOUR work.

BALTIMORE-MARYLAND
ENGRAVING COMPANY

BALTIMORE, MARYLAND

Your advertisement is being read in every State and in 25 Foreign Countries

THERE IS A TYCOS OR TAYLOR TEMPERATURE INSTRUMENT FOR EVERY PURPOSE



Tycos
TEMPERATURE INSTRUMENTS
INDICATING · RECORDING · CONTROLLING

Recorders

help make efficient milk handling. No need to overrun a batch when you can see the time laid before your eyes on the chart. No danger of burning or not pasteurizing when you use a *Tycos* Recorder to guide you. However, pasteurizer temperatures may be maintained and timed automatically by *Tycos* Regulators. Full particulars given in *Tycos* Milk Plant Catalog. Yours for the asking.

Taylor Instrument Companies
ROCHESTER, N. Y., U. S. A.
CANADIAN PLANT, TYCOS BUILDING
110-112 CHURCH ST., TORONTO, CANADA

GUERNSEYS

The Quality--Quantity Breed

The Advanced Register records of the Guernsey breed offer a wide field for research and study.

We find, for instance, that the addition of approximately 2500 records made during 1924, to the 17,000 that existed before January 1, 1924, raises the average production of the breed by over five pounds of butter fat and over 100 pounds of milk.

Information concerning the Guernsey breed is gladly given.

THE AMERICAN GUERNSEY CATTLE CLUB
Box DS PETERBORO, N. H.

Wagner's Precision Milk and Cream Test Bottles with **Indestructible Black Graduation,** guaranteed not to decolorize; eye strain is practically eliminated, thereby insuring accuracy, efficiency, and contented operators; the easy reading gives a sense of secureness to the operator, it fortifies him against unjust claims; it makes retesting and rereading unnecessary; saving time and wages.

Some of the testimonials received, read:

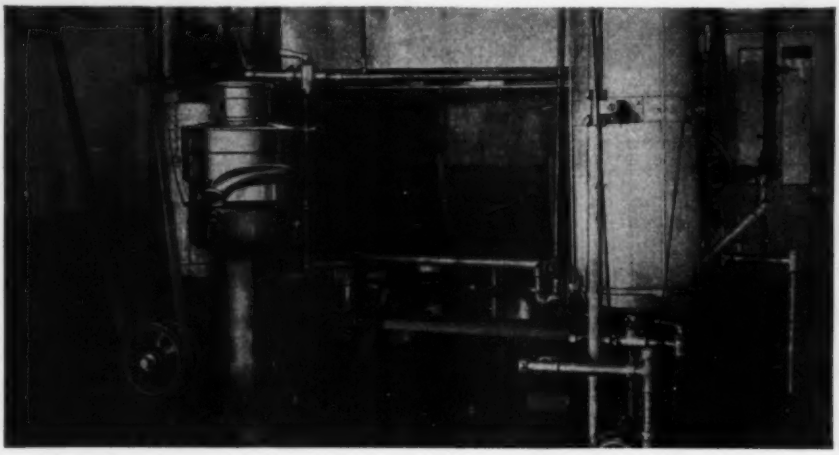
"The Wagner Test Bottles with Indestructible Black Graduation are worth their weight in gold."

Order from us or your jobber.

The Wagner Glass Works
ESTABLISHED 1887
Manufacturers and Inventors of Glassware and Apparatus Pertaining to the testing of Milk and its products.

695-697 E. 132nd St.
New York, N. Y.
U. S. A.

Your advertisement is being read in every State and in 25 Foreign Countries



"The most perfect separator I have ever used"

—says Mr. Walter Zbinden, proprietor of the Pine Valley Cheese Factory, Neillsville, Wis. "I skim from 20,000 to 35,000 lbs. of milk every day and the skim-milk generally tests less than one one-hundredth of one per cent, *but never more*. It really has a capacity of 10,000 pounds an hour." This No. 90 De Laval is shown in the illustration.

The reputation of De Laval Separators is founded on skimming efficiency as established by hundreds of users who have had the same experience as the Pine Valley Cheese Factory. This skimming efficiency is not made possible by separating the milk while it is at an impractically high temperature, or by feeding milk to the separator at less than its rated capacity. De Lavals skim clean at any reasonable working temperature, and do it when run at their full rated capacity. Regardless of whether it is most economical for you to separate with milk at Pasteurizing temperature or many degrees lower, a De Laval will get you more and better cream.

Ask for full information

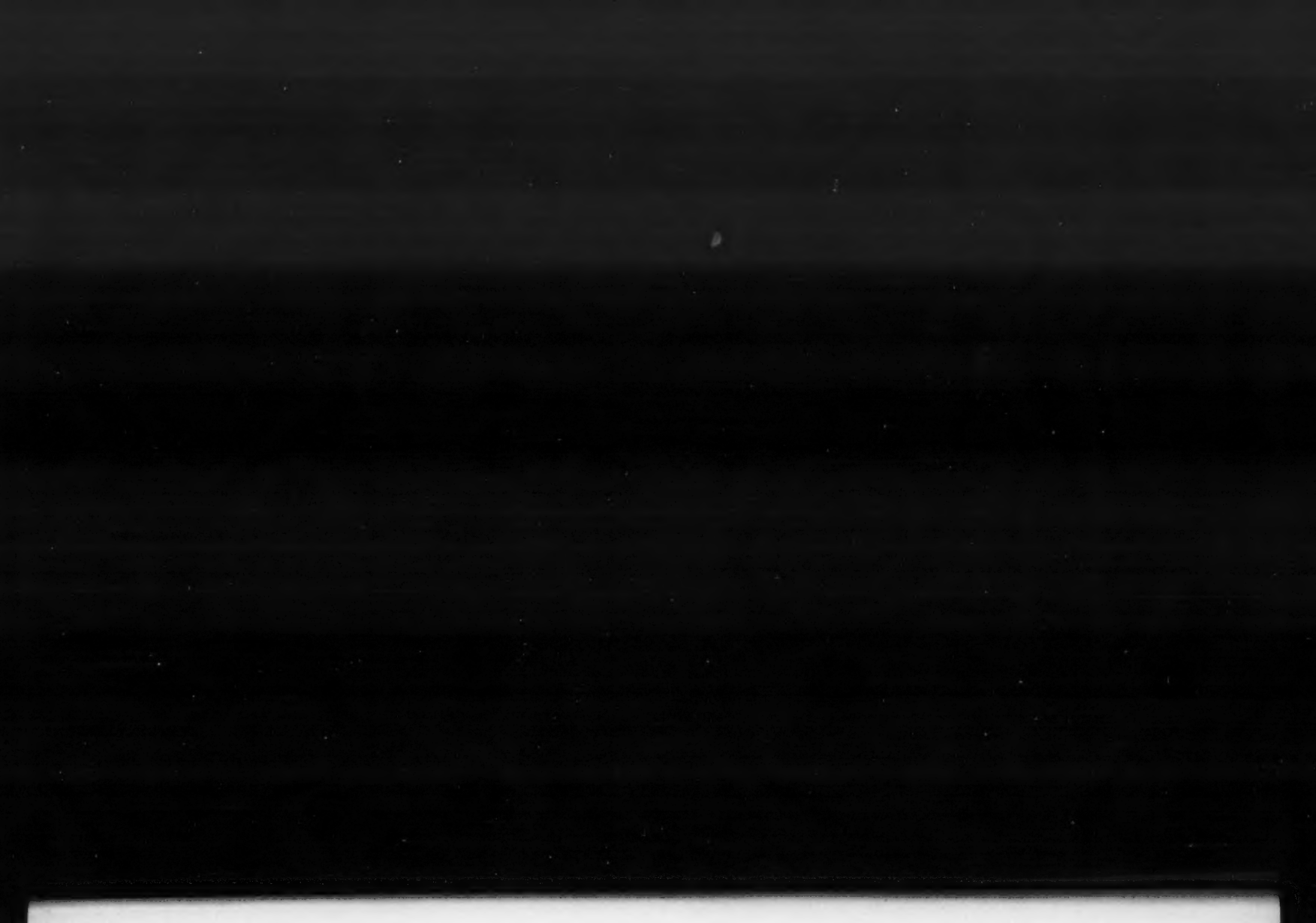
The De Laval Separator Company

NEW YORK
165 Broadway

CHICAGO
600 Jackson Boulevard

SAN FRANCISCO
61 Beale Street

Your advertisement is being read in every State and in 25 Foreign Countries



Safe - Reliable - Uniform

K. V. P. Genuine Vegetable Parchment is a necessity for the Dairy Food Products Industry. It is made—

Free from taint or contamination.

Cream-white color adds to attractiveness of wrapped packages.

Printing inks tested and proven suitable for special requirements.

Dairy Food Products are too sensitive and valuable to experiment with questionable or unknown vegetable parchment protective wrappers or liners.

A few cents difference in initial cost may lose dollars in the final test.

KALAMAZOO VEGETABLE PARCHMENT COMPANY

KALAMAZOO, MICHIGAN.

A chemical research department maintained for your service and convenience.

MARSCHALL RENNET AND COLOR

STRONG PURE

DEPENDABLE

Made in the largest and best equipped Rennet factory in America!

THE MARSCHALL DAIRY LABORATORY

MADISON, WISCONSIN

The Determination of Hydrogen Ions

Wm. Mansfield Clark, Ph.D.
U. S. Hygienic Laboratory, Public Health Service

Recognized as the authoritative text book on hydrogen ion work. Discusses the fundamental theories involved as well as practical applications. A comprehensive bibliography is a feature.

Price, $5.00

THE WILLIAMS & WILKINS COMPANY

Publishers of Scientific Books and Periodicals

BALTIMORE, MARYLAND

CHRISTENSEN'S MILK GRADING APPARATUS

FOR

The Reduction and Fermentation Test

This simple and inexpensive method of determining number and kind of bacteria in milk is bound to be generally adopted.

Our apparatus
"THE MILK GRADER"
has no equal:

Used for either test or the combined test.
Temp. Regulation for gas and electricity.
Samples are sufficiently large 25 cc.
Copper Dipper for collecting the samples.
Tubes may be sterilized in the apparatus.
Water Level is automatically adjusted.

Circulars on Request

OHIO FOOD & DAIRY LABORATORY

VALENTINE CHRISTENSEN
Chemist and Bacteriologist

145 East Fourth Street
CINCINNATI, OHIO

THE STANDARD FOR NEARLY FORTY YEARS

TRADE MARK

Paterson Vegetable Parchment

"Nearest to Perfection"

Nearly forty years ago we were making Vegetable Parchment. One does not specialize for nearly forty years without coming very close to Perfection.

The Paterson Parchment Paper Co.

Passaic, New Jersey

DIFCO

BACTO-NUTRITIVE CASEINATE AGAR

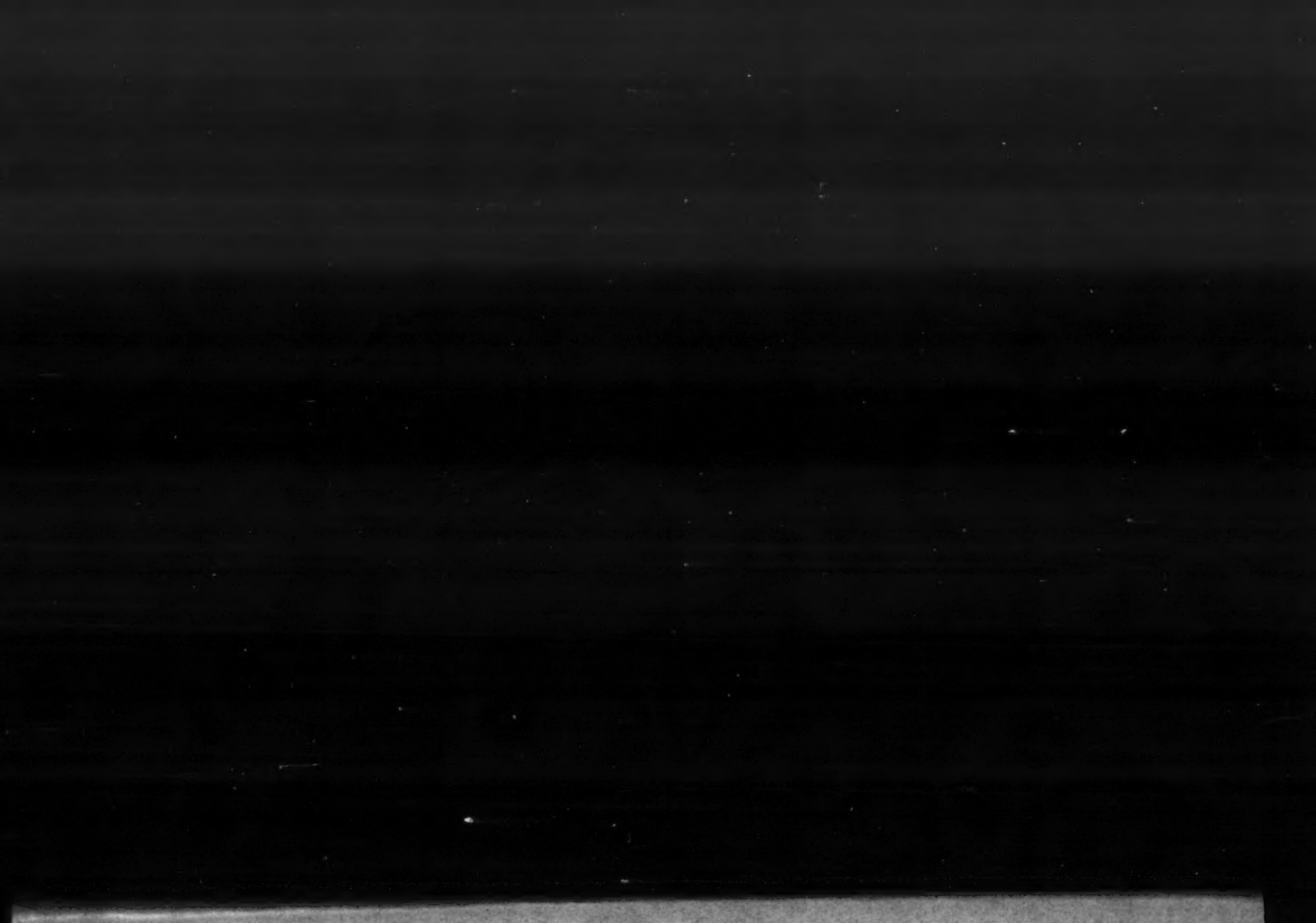
Bacto-Peptonized Milk . . .	7 grams
Sodium Caseinate (Difco) . .	3 grams
Agar (Special)	12 grams

On Bacto-Nutritive Caseinate Agar the acid-forming colonies are surrounded by a white zone due to the acid precipitation of the casein. Peptonizing organisms are distinguished by a transparent halo. The medium is designed to give a differential as well as the total count for milk analysis.

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS

In the research and development of Bacto-Peptone and Dehydrated Culture Media

DIGESTIVE FERMENTS COMPANY

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